FINAL REPORT

SITE DESIGNATION STUDY FOR THE PORT EVERGLADES HARBOR OCEAN DREDGED MATERIAL DISPOSAL SITE EXPANSION: MAY 2011 SURVEY RESULTS

Contract No. W912EP-09-D-0013-0015

Prepared for

U.S. Army Corps of Engineers
Jacksonville District
701 San Marco Boulevard
Jacksonville, Florida 32207-8175

Prepared by

ANAMAR Environmental Consulting, Inc.
2106 NW 67th Place, Suite 5
Gainesville, Florida 32608

(ANAMAR Project No. 11-0003)

January 2012

Contents

Maps

Figures

Tables

Appendices

(All appendices are included only on a CD with this final report)

ACRONYMS AND ABBREVIATIONS

AET	apparent effects threshold
ASTM	American Society for Testing and Materials Standards
CAS	Columbia Analytical Services, Inc.
CCC	criterion continuous concentration (synonymous with 'chronic')
cf.	*confer* (Latin; equivalent to 'compare' in English)
CMC	criteria maximum concentration (synonymous with 'acute')
CQAR	chemical quality assurance report
CTD profiler	conductivity-temperature-depth profiler
DMS	duplicate matrix spike
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERL	effects range-low
FDA	U.S. Food and Drug Administration
FLMNH	Florida Museum of Natural History
FTU	formazin turbidity units
FWC	Florida Fish and Wildlife Conservation Commission
GIS	geographic information system
HMW	high molecular weight
ICV	initial calibration verification
LCS	laboratory control sample
LMW	low molecular weight
MB	method blank
MDL	method detection limit
MDS	multidimensional scaling
MRL	method reporting limit
MS	matrix spike
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
nmi	nautical mile(s)
NOAA	National Oceanic and Atmospheric Administration
ODMDS	Ocean Dredged Material Disposal Site
OSV	Ocean Survey Vessel
PAH	polynuclear cyclic aromatic hydrocarbon (= polycyclic nuclear aromatic hydrocarbon)
PAR	photosynthetically active radiation (= photosynthetically active radiance)
PAR units	µmol photons/square meter/second
PCB	polychlorinated biphenyls
QA/QC	quality assurance/quality control
RPD	relative percent difference
RSD	relative standard deviation

Acronyms and Abbreviations (continued)

SAFMC	South Atlantic Fishery Management Council
SAP/QAPP	Sampling and Analysis Plan/Quality Assurance Project Plan
SERIM	Southeast Regional Implementation Manual (EPA and USACE 2008)
SL	standard length
SOP	standard operating procedure(s)
SRM	standard reference material
TEL	threshold effects level
TOC	total organic carbon
UF	University of Florida
USACE	U.S. Army Corps of Engineers
WPD	Water Permits Division

EXECUTIVE SUMMARY

The survey described in this report is part of the required environmental documentation for the Ocean Dredged Material Disposal Site (ODMDS) designation process as stated in 40 CFR §228.6(b) and fits within Phase III of this process as defined in Science Applications International Corporation (1986).

This report details the field and analytical methods, results, and discussion of the May 2 through 6, 2011, Port Everglades Harbor ODMDS expansion survey. Physical, chemical, and biological data obtained during the survey are compared between stations and between areas and will also be used as baseline data in future comparative studies.

Sampling stations within and adjacent to the two proposed expansion areas (Map 1) were selected by the U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (EPA) based on guidance document recommendations (i.e., Science Applications International Corporation 1986, Pequegnat et al. 1990) and results of previous surveys of the area (e.g., March 1986 camera and sidescan sonar survey by Continental Shelf Associates [1986], August 1998 sidescan sonar survey by EPA [2000]).

Field team participants consisted of professionals from ANAMAR Environmental Consulting, Inc., USACE, EPA, the Ocean Survey Vessel (OSV) *Bold*, and the Florida Museum of Natural History (FLMNH). The sampling equipment was operated by OSV *Bold* personnel.

In Situ and Physical Water Results

Water column profiles were taken from Stations PE11-6 and PE11-7 inside the expansion areas. Results were similar between the two stations.

Temperature ranged from 8.1°C at Station PE11-7 near the seafloor (722 feet) to 26.7°C in an isothermic layer extending from the water's surface to about 70 feet deep at both stations. A second isothermal layer was found at approximately 377 to 426 feet of water in the Station PE11-6 profile, but this layer showed some temperature change (0.1°C per 16 feet) in the PE11-7 profile. Mean temperature change was about 0.4°C per 16 feet of water depth at both stations. A thermocline of 1.0°C or more temperature decrease per 16 feet was observed between about 180 and 280 feet deep at both stations.

Dissolved oxygen ranged from 4.2 to 7.3 mg/L at both stations. Salinity was constant (35.0 to 36.4 ppt) at both stations. Turbidity ranged from 0.1 FTU (clear water) within the upper water column at both stations to 1.8 FTU at Station PE11-7 near the surface. The photic zone (defined here as greater than or equal to 2% of surface photosynthetically active radiation [PAR] values) was found within approximately 200 feet of the water's surface at both stations.

Water physical samples collected from four layers of the water column at Station PE11-6 revealed total suspended solid concentrations ranging from 6.0 mg/L in 213 feet of water to 13.0 mg/L in 410 feet of water.

Sediment Physical and Chemical Results

Sediment was collected from five stations (including inside and outside the expansion areas) for chemical and physical analysis. Station PE11-1, found inside the ODMDS, was also sampled.

Physical Characteristics—Samples contained mostly sand (55.7% to 64.9% by weight), of which 49.5% to 54.3% was fine sand. Silt and clay combined was also a major component of samples, representing 35.1% to 44.3% (by weight) per sample, with the highest percentage being found at Station PE11-3. Samples contained more silt (23.3% to 28.9%) than clay (12.1% to 15.4%). Gravel was not present in any sample. Percent total solids ranged little (70.7% and 74.1%) among samples.

Based on physical analysis results, the samples from within the expansion areas and the ODMDS have analogous physical characteristics as those taken from outside these areas (see the following summary table).

Summary of Sediment Grain Size Analysis in Relation to the Expansion Areas[1]

Location of Pooled Samples[2]	% Gravel[3] (Range)	% Sand[3] (Range)	% Silt & Clay[3] (Range)	USCS[4] Classification(s)
Inside ODMDS	0.0	64.3	35.7	SC-SM
Inside Expansion Areas	0.0–0.0	55.7–64.9	35.1–44.3	SC-SM (all samples)
Outside Expansion Areas	0.0–0.0	58.3–63.6	36.4–41.7	SC-SM (all samples)

[1]See Table 8 for a complete summary of grain size and other physical parameters.
[2]Results of the ODMDS sample (Station PE11-1) were averaged with the field split sample.
[3]Particle sizes: gravel ≥4.750 mm, sand = 0.075–4.749 mm, silt and clay <0.075 mm
[4]Unified Soil Classification System codes are: SC = clayey sand, SM = silty sand

Metals, Total Organic Carbon, and Organotins—The ODMDS held the maximum detected concentration of all organotin cations and total organotins (as tin). The ODMDS also held maximum detected levels of 50% of the 10 metals tested along with total organic carbon. The expansion areas held maximum detected levels of 40% of the 10 metals tested. The maximum detected concentration of chromium (13.2 mg/kg) came from outside the expansion areas. No sample approached the threshold effects level (TEL), effects range-low (ERL), or apparent effects threshold (AET) values.

Organochlorine Pesticides—Detected amounts of pesticides were found only inside the ODMDS. None of the 25 pesticides tested were detected inside or outside the expansion areas. All detected analyte concentrations were below the TEL, ERL, and AET values. See Section 5.2.2 for a discussion of a discrepancy between the concentration of p,p' (4,4')-DDD found in the PE11-1 sample (inside the ODMDS) and that of the field split sample. The difference in p,p' (4,4')-DDD concentrations between the PE11-1 sample and its field split may be attributable to heterogeneity of the sample and matrix interferences as indicated by results of laboratory screening (See Section 5.2.2 for the QA/QC review of pesticide results of this sample).

Polynuclear Aromatic Hydrocarbons (PAHs)—The ODMDS had results which exceeded the MRL in 78% of the 18 PAH analytes tested, and held the maximum detected concentration in the same 14 PAHs. Results of the Station PE11-1 sample from inside the ODMDS exceeded the TEL in acenaphthene, dibenzo(a,h)anthracene, fluoranthene, and phenanthrene with

concentrations of 8.8, 6.5, 120, and 100 µg/kg, respectively. No other sample had detected concentrations above the MRL. Five PAH analytes were detected inside the expansion areas, and the same number was detected outside these areas. Analytes detected inside and outside the expansion areas were present only in concentrations below the MRL (J-qualified).

Polychlorinated Biphenyl (PCB) Congeners—The ODMDS had detected levels of 14 (53.8%) of the 26 PCB congeners, all of which had lower concentrations than the MRL. The ODMDS also had maximum detected concentrations of both total EPA Region 4 PCBs and total National Oceanic and Atmospheric Administration (NOAA) PCBs. In contrast, none of the 26 PCB congeners tested were detected inside the expansion areas or in the surrounding area. No analyte concentration exceeded the TEL, ERL, or AET in any sample.

Benthic Infaunal Results (Appendix D)

Three replicate grab samples were taken from each of five stations inside and outside the expansion areas and inside the ODMDS. Infaunal analysis results discussed below were taken from Barry Vittor & Associates (2011).

Wet Weight Biomass—The greatest mean total biomass was found inside the ODMDS (0.2285 grams). Mean total biomass was significantly greater inside the expansion areas (0.2084 grams) compared to outside these areas (0.1124 grams).

Taxonomic Richness & Diversity—A total of 1,053 individual organisms representing 141 taxa were enumerated and identified from the survey.

The ODMDS had the greatest mean total infaunal density (3,266.7 individuals per square meter [m^2]). The expansion areas held a mean total infaunal density of 1,700.0 individuals per m^2, which was greater than that found outside these areas (1,054.2 individuals per m^2). Due to the variability of biomass values between stations, no statistically significant difference was found for density in relation to the expansion areas.

Mean Shannon diversity index values varied little between the expansion areas (3.53) and outside these areas (3.50), and no significant difference was found between these values. Mean taxa per replicate sample (taxa richness) varied somewhat between the expansion areas (30.2) and outside these areas (23.7), but was greatest inside the ODMDS (47.0).

Cluster and Multidimensional Scaling Analyses—Results of these analyses revealed that Stations PE11-3 and PE11-4 were most similar to one another, while Stations PE11-1, PE11-2, and PE11-5 shared similar infaunal parameters (although PE11-1 [inside the ODMDS] showed the least similarity).

Epifaunal Results (Tables 13–29, Figures 4–13)

Two replicate trawl tows were taken from each of four stations (two inside and two outside the expansion areas).

Wet Weight Biomass—Fish biomass was nearly twice that of invertebrate biomass in most samples. The shallowest station, Station PE11-9 (outside the expansion areas), had the highest

total biomass (1.41 kg per 1,000 m^2). Total biomass outside the expansion areas (0.76 kg per 1,000 m^2) was nearly twice that of inside these areas (0.44 kg per 1,000 m^2).

Taxonomic Richness and Diversity—Trawled invertebrates numbered 1,562 individuals belonging to 44 taxa. Fishes numbered 371 and represented 18 species.

Total epifaunal densities (individuals per 1,000 m^2) averaged 51.85 per station and ranged from a high of 87.79 at Station PE11-9 (outside the expansion areas) to a low of 30.47 at Station PE11-7 (inside the expansion areas). Night tows averaged a much higher number of individuals per station (292.75 individuals per tow by night) compared to day tows (190.50 individuals per tow by day), suggesting that benthos of the slope adhere to defined 24-hour activity patterns despite low light levels.

When station data were pooled in relation to the expansion areas, the highest total epifaunal density occurred outside of the expansion areas, at 58.78 individuals per 1,000 m^2.

Shannon diversity index values ranged from 1.54 to 2.08. The mean Shannon diversity index value was slightly greater outside the expansion areas (1.81) versus inside these areas (1.69).

Abundant Epifaunal Taxa—Abundant epifaunal taxa are defined here as those representing at least 2% of total invertebrates or fishes captured by trawl during the survey. Six invertebrate taxa and six fish species fit this definition. The most abundant invertebrate taxon was the sea star *Coronaster briareus* and the most abundant fish species was the Gulf Stream flounder (*Citharichthys arctifrons*).

Pooled station data showed the highest total abundant taxa density to be outside the expansion areas (39.47) compared to inside these areas (35.55).

Federally Managed Taxa—State and federally managed taxa represented 65.6% of all trawled epifauna, numbering 1,268 individuals from 15 taxa. South Atlantic Fishery Management Council (SAFMC) manages six taxa, while Florida Fish and Wildlife Conservation Commission (FWC) manages the remaining nine taxa in federal waters adjacent to Florida. In addition, the management of hydroids (hydrozoa), soft corals (Alcyonacea), and sea anemones (actiniaria) in federal waters is expected to be handed over to FWC from SAFMC by early 2012. The sea star *Coronaster briareus* represented the great majority (69.2%, n = 877) of managed individuals captured by trawl.

Density of managed taxa was similar inside the expansion areas versus outside these areas (range = 33.40 to 33.96 individuals per 1,000 m^2). Samples from outside the expansion areas had somewhat more managed individuals (n = 709) compared to samples from inside these areas (n = 559) but the difference is not considered significant.

Nonindigenous Species

No nonindigenous species were identified from trawl catches and infaunal samples.

Tissue Analysis Results

Edible tissues were extracted from Jonah crab (*Cancer borealis*) and spotted hake (*Urophycis regia*) from trawl samples for bioaccumulation analysis. Three spotted hake samples (plus a field split sample) and three Jonah crab samples were analyzed for the analytes summarized below. Samples were taken from inside and outside the expansion areas.

Total Lipids—Jonah crab samples had a mean total lipid concentration of 0.43%. Spotted hake samples had a mean lipid concentration of 0.35%.

Bioaccumulation of Metals and Organotins—Of the three Jonah crab samples, most metal and all organotin results were well below the U.S. Food and Drug Administration (FDA) limit for crustacea. The exception was arsenic, which resulted in concentrations of 106 to 122 mg/kg in the three crab samples, exceeding the FDA level for this analyte (76.0 mg/kg). The highest arsenic concentration originated from a sample taken at Station PE11-14, inside the proposed expansion areas. All nine metal analytes tested were detected in levels greater than the MDL. Most (55.6%) of the maximum detected concentrations of tested metals came from stations outside the expansion areas.

Of the three spotted hake samples and field split sample tested, concentrations were detected above the MDL in all metals except silver, which was not detected in any sample. Maximum detected concentrations of all eight detected metals came from stations outside the proposed expansion areas. All spotted hake sample mercury concentrations were below the 0.5-mg/kg threshold for limited consumption given by the Florida Department of Health and the 1-mg/kg FDA guidance criteria for edible fish tissue.

Taking both species into consideration, the only analyte concentration to exceed applicable FDA levels was arsenic, which exceeded this limit in the three Jonah crab samples tested. These samples represent stations inside and outside the proposed expansion areas.

Bioaccumulation of Organochlorine Pesticides—Overall, only (12.0%) of the 25 organochlorine pesticides tested were detected among the species sampled. The three detected analytes were in concentrations less than the MRL. No crab sample exceeded FDA levels for crustacea for the analytes tested. Results suggest no significant difference in pesticide bioaccumulation between stations or in relation to the expansion areas.

Bioaccumulation of Polynuclear Aromatic Hydrocarbons—Of the 18 PAH analytes tested, 11 (61.1%) resulted in non-detects for all samples. Of the seven detected analytes, all were detected in concentrations below the MRL. Although samples taken from outside the expansion areas held the most maximum detected concentrations of PAHs for both Jonah crab and spotted hake, this is not considered significant since none of the resultant concentrations exceeded the MRL in any sample.

Bioaccumulation of Polychlorinated Biphenyls—Overall, 4 (15.4%) of the 26 PCB congeners tested were detected in any tissue sample (Jonah crab or spotted hake), and detected PCBs were in concentrations less than the MRL. There are currently no FDA levels for the PCB congeners and taxa tested in this study, and all samples were below the FDA level for total EPA Region 4 PCBs. No significant differences were observed between stations or in relation to the expansion areas based on these results.

Conclusions

Greater sediment chemical concentrations were observed inside the ODMDS for certain metals, organotins, organochlorine pesticides, PAHs, and PCBs. Sediment chemical results were very similar inside and outside the expansion areas. Some parameters appeared to differ significantly in relation to the expansion areas. Greater values were identified outside the expansion areas involving total epifaunal biomass, mean epifaunal density, mean epifaunal Shannon diversity index values, and total abundant epifaunal taxa density compared to values inside the expansion areas.

1 INTRODUCTION

The U.S. Environmental Protection Agency, Region 4 (EPA) and the U.S. Army Corps of Engineers, Jacksonville District (USACE) share responsibility for control and management of the Port Everglades Harbor ODMDS under the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1401 *et seq.*, MPRSA). There are three distinct but interrelated activities for which EPA and/or USACE have responsibilities involving ocean disposal of dredged material (EPA and USACE 2008):

1. Designation or selection of sites for ocean disposal of dredged material.
2. Evaluation of the suitability of dredged material for ocean disposal.
3. Management and monitoring of ODMDS to ensure compliance with the MPRSA.

The MPRSA assigns basic responsibility to EPA and USACE for ensuring that ocean dredged material disposal activities will not unreasonably degrade or endanger human health, welfare, amenities, or the marine environment (MRPSA §102–103). Section 102 of the MPRSA authorizes EPA to designate sites or times at which dumping may occur and establish criteria for reviewing and evaluating permit applications, including those for dredged material. It also requires EPA, in conjunction with USACE, to develop site management plans for dredged material disposal sites. Section 103 of the MPRSA authorizes USACE to issue permits subject to compliance with the EPA environmental criteria (Ocean Dumping Criteria at 40 CFR Part 227) and EPA concurrence with USACE's finding of compliance. Section 103(b) authorizes USACE, with EPA concurrence, to select alternative project sites of limited duration for disposal of dredged material in ocean waters when the use of a site designated by EPA is not feasible.

Site designation has two primary purposes. Sites are selected that minimize adverse environmental effects and minimize the interference of dumping activities with other activities in the marine environment (Science Applications International Corporation 1986). The process is designed to ensure that temporary perturbations in water quality are reduced to normal ambient seawater levels before reaching any beach, shoreline, marine sanctuary, or geographically limited fishery or shellfishery (40 CFR §228.5[a, b]).

The designation of new ODMDS boundaries requires a formal evaluation of the proposed area in which the potential environmental impacts associated with disposal of dredged material are examined. Before the site designation or expansion process can begin, USACE must demonstrate the need for the ODMDS expansion or site designation (40 CFR §6.203[a] and 40 CFR §1502.13). Once the need for an expanded ocean disposal site is established, potential expansion areas are screened for feasibility through the zone-of-siting feasibility process. After this process is completed, expansion areas are selected for further evaluation. Expansion areas are evaluated using EPA's ocean disposal criteria at 40 CFR Part 228. These regulations outline 5 general criteria and 11 specific factors upon which to base site selection or expansion (40 CRF §228.5–228.6). Of the expansion areas that satisfy these criteria, the site that best complies with the criteria is selected as the preferred expansion area for formal designation through rulemaking published in the *Federal Register*.

1.1 Background

The Port Everglades Harbor ODMDS is square and measures approximately 1 nmi^2. The site is positioned east-northeast of Port Everglades (Map 1), approximately 4 nmi offshore and centered at 26° 7.50'N and 80° 1.50'W (EPA and USACE 2004) at the western edge of the Florida-Hatteras slope near the northern terminus of the Straits of Florida (Emery and Uchupi 1972). Water depths range between 640 and 705 feet and the bottom is primarily soft substrate with scattered rubble (EPA 2004). The ODMDS is strongly affected by the warm Florida Current (part of the Gulf Stream; the western leg of the North Atlantic gyre) (Ulanski 2008).

The shelf and slope of the area are devoid of significant channels or canyons, although step-like terraces (representing submerged shorelines) are present as far south as Miami, Florida (Emery and Uchupi 1972). Three rocky reef systems run parallel to the shoreline between the mainland and the disposal site in water up to 120 feet deep (Freeman and Walford 1976), but do not extend into the vicinity of the Port Everglades Harbor ODMDS itself. Rock gathered from deeper water (758 to 872 feet) beyond the ODMDS were identified by EPA (1999) as part of the Suwannee Limestone Formation and described as slightly dolomitic, fossiliferous limestone with magnesite dendrites. This early Oligocene formation is exposed in a narrow range of depths, including the depths mentioned above, but does not appear to extend upslope (Hine 1997). Instead, the geology of the Port Everglades Harbor ODMDS and proposed expansion areas is composed of clays and limestone of the Miocene-age Hawthorne Formation along with the Oligocene/Miocene-age Tampa member of the Arcadia Formation (Hine 1997). The Tampa member is composed of limestone with some dolostone, sand, and clay. The Hawthorne Formation and the Tampa member of the Arcadia Formation are both overlain in the area with undifferentiated Pleistocene deposits (Hine 1997). These formations form the upper portion of the Floridan Aquifer system in parts of South Florida. Although submarine groundwater discharge has been documented in the form of springs off Florida's east coast to at least 492 feet deep (Emery and Uchupi 1972), none are known from the vicinity of the Port Everglades Harbor ODMDS.

The Port Everglades Harbor ODMDS received final designation by EPA in February 2005 (McArthur 2011) following the completion of a final environmental impact statement dated July 2004. Based on recent capacity modeling results by Taylor Engineering (2010), the site is now known by USACE and EPA to be insufficient in size to contain the dredged material footprint from a proposed deepening and widening project at Port Everglades Harbor (McArthur 2011). The process of expanding the existing ODMDS will include an environmental assessment (EA) to support the action (McArthur 2011) and to determine whether an environmental impact statement (EIS) is required for this action under 40 CFR §1508.9. The results of this survey will provide the added baseline data needed to be incorporated into the EA in support of the proposed expansion.

1.2 Survey Rationale and Selection of Expansion Areas

Before an expansion area can receive final designation, adequate environmental documentation must be prepared, reviewed, and approved by EPA (Pequegnat et al. 1990). The information should provide not only a descriptive characterization of each expansion area and its respective environs, but should also provide a functional understanding of the fate of dredged material at the enlarged site. All studies for the evaluation and potential selection of an expanded ODMDS

were conducted in accordance with the EPA ocean dumping criteria mentioned previously (40 CFR §228.5–228.6). The survey described in this document is part of the required environmental documentation for the ODMDS designation process as stated in 40 CFR §228.6(b), and fits within Phase III of the site designation process as defined in Science Applications International Corporation (1986).

Criteria established by EPA to manage ODMDSs identifies the need for a designation survey. These criteria include the need to present the resultant designation study as part of the National Environmental Policy Act (NEPA) documents (40 CFR §228.6(b)). Three parts of the NEPA regulations apply directly to the expansion study:

- Emphasis upon alternatives, including the proposed action. It is expected that environmental documentation will evaluate the environmental impacts of the proposal and all reasonable alternatives, which would minimize adverse impacts on the environment. Therefore, the survey must determine what is present to be impacted.
- A succinct description of the affected environment, including the area outside the disposal site that may be modified by direct or indirect effects of the disposal process.
- An analysis of significant impacts of the disposal and, where appropriate, supplying practicable means of mitigating adverse environmental impacts.

The expansion of an ODMDS will be executed by EPA and USACE and will be based on:

> Environmental studies of each site, regions adjacent to the site, and on historical knowledge of the impact of dredged material disposal on areas similar to such sites in physical, chemical, and biological characteristics (40 CFR §228.4).

Two expansion areas, each approximately 4 nmi^2 in size, have been identified for evaluation. They share much of their southern and eastern boundaries with the current Port Everglades Harbor ODMDS, which constitutes approximately 25% (1 nmi^2) of each expansion area. The expansion areas overlap one another to a large extent, but differ slightly in their western and northern boundaries. Expansion Area 1 extends slightly farther west compared to Area 2, which is more elongate along its north-south axis (see Map 1). Area 1 is configured for a disposal release zone on an east-west orientation, while Area 2 is designed for a north-south oriented disposal release zone. Each expansion area is designed to contain the disposal footprint out to the 1-cm contour line of its respective release zone orientation (Taylor 2010). Preliminary findings suggest the expansion areas are primarily composed of soft sediments, as only a limited amount of hardbottom was observed in plan-view camera photography conducted during the May 2011 expansion survey (McArthur 2011).

1.3 Purpose and Objectives

In accordance with recommendations provided in Pequegnat et al. (1990), the sampling program is designed to fulfill two primary purposes:

1. Yield data descriptive of the site environs, thus characterizing the site sufficiently for preparation of an acceptable EA and/or environmental impact statement.
2. Provide data compatible and comparable with that of a potential monitoring program to be carried out after final designation of the disposal site.

The above recommendations can be supplemented with those of Science Applications International Corporation (1986) which states that a site survey is used to identify unknowns in previously gathered data and to confirm information already obtained, with a focus on EPA's ocean disposal criteria (40 CRF §228.5–228.6).

The purpose of the site expansion survey is to characterize the environment within the proposed expansion boundaries and the surrounding area, including sediment and water physicochemical properties and biological resources (infauna and epifauna). Results of this survey will be evaluated by the USACE and EPA to select a preferred area for expansion of the current Port Everglades Harbor ODMDS.

The information obtained during the May 2011 survey is considered baseline data. Information gained from this and future studies will be used to guide management decisions relative to future disposal activities at the expanded site.

1.4 Units of Measure

In keeping with Imperial units, as is traditional in U.S. dredging-related documents, water depths are noted in feet. Tabulated water depths are supplemented with metric units (meters). Large distances, ship lengths, and speeds are referred to in terms of nautical miles (nmi), feet, and knots, respectively, for comparison and continuity with nautical charts of U.S. waters (Maptech 2007). The widely used seconds and minutes are used here to measure duration or frequency (e.g., trawl tow times); the second is accepted by the International System of Units (Bureau International des Poids et Mesures 2006). Times given in this document refer to the Eastern time zone, where daylight saving time is observed. Photosynthetically active radiation (PAR) is measured in units of µmol photons/square meter/second but is stated as PAR units or simply 'units' for short. Water turbidity is measured here in the widely used formazin turbidity units (FTU). Temperature is given using the metric unit Celsius (or °C). Wind speed is given in knots (nmi/hour) but is supplemented with units of the Beaufort Wind Force Scale in Section 4 (Results and Discussion). Chemical analyte concentrations and all faunal weights and measures are given in metric units. The reasons for the use of metric units include allowing comparison with other analytical and biological studies and because the comprehensive decimal system is the standard for science (Fenna 2002).

2 FIELD METHODS AND MATERIALS

2.1 Project Design and Rationale

The sampling scheme and parameters for this study were determined in accordance with Section 102 of the MPRSA and with 40 CFR 228, Pequegnat et al. (1990), and the *Southeast Regional Implementation Manual (SERIM) for Requirements and Procedures for Evaluation of the Ocean Disposal of Dredged Material in Southeastern U.S. Atlantic and Gulf Coast Waters* (EPA and USACE 2008).

2.2 Personnel and Responsibilities

USACE contracted ANAMAR Environmental Consulting, Inc. to provide field and project management support to USACE and EPA. Field participants of the project consisted of a diverse team from ANAMAR, EPA, USACE, the Ocean Survey Vessel (OSV) *Bold*, and the Florida Museum of Natural History (FLMNH) at the University of Florida. The sampling equipment was operated by OSV *Bold* personnel. The coordination of personnel from these entities allowed sediment, water, invertebrate, and fish samples to be collected along with measurements of water column parameters for analysis as outlined in this document. The participant's strong science backgrounds combined with excellent decision-making skills allowed for a smooth-flowing and successful survey. ANAMAR managed subcontracting and sample custody with laboratories and conducted the bulk of the comparisons, including all epifaunal analyses and quality control. ANAMAR also received, reviewed, and performed quality control on laboratory results; compiled, compared, and summarized resultant data; and generated conclusions. These data are presented in this report.

Field Participants of the May 2011 Site Expansion Survey

Name	Survey Responsibility	Organization
Christopher McArthur	Chief Scientist	EPA—WPD, Atlanta, GA
Elizabeth Walls	Watch Stander	EPA—WPD Atlanta, GA
Jennifer Derby	Watch Stander	EPA—WPD Atlanta, GA
Ron Miedema	Watch Stander	EPA—WPD West Palm Beach, FL
Joelle Verhagen	Project Lead, Watch Stander	USACE—Jacksonville District, Jacksonville, FL
Rob Bronson	Watch Stander	USACE—Jacksonville District, Jacksonville, FL
Bob Musser	Watch Stander	Port Everglades, Fort Lauderdale, FL
Nadia Lombardero	Sediment and Water Sampler	ANAMAR, Gainesville, FL
Jason Seitz	Lead Biologist	ANAMAR, Gainesville, FL
Amanda Bemis	Epifaunal Invertebrate Sampler	FLMNH (UF)*, Gainesville, FL
John Slapcinsky	Epifaunal Invertebrate Sampler	FLMNH (UF)*, Gainesville, FL
Crew of OSV *Bold*	Equipment Operations	Seaward Services, OSV *Bold*

*FLMNH (UF) = Florida Museum of Natural History at the University of Florida

2.3 Facilities and Sampling Operations

Sampling efforts were undertaken using the EPA-owned OSV *Bold*. The OSV *Bold* is a 224-foot-long ex-U.S. Navy Stalwart (USNS) Class Tactical Auxiliary General Ocean Surveillance (T-AGOS) ship reconfigured and outfitted by EPA in 2004 as an environmental survey vessel for use along the U.S. coasts (EPA 2011). Originally named the USNS *Vigorous* by the Navy in 1989, the OSV *Bold* now replaces EPA's OSV *Peter W. Anderson* (EPA 2011). The *Bold* is equipped for all sample and data collection discussed in this document. Many instruments, such as the conductivity-temperature-depth (CTD) profiler, are maintained onboard the vessel. The size and design of the *Bold* conforms well to vessel requirements outlined in Pequegnat et al. (1990). Onboard facilities include wet and dry laboratories designed to allow processing of samples and ice machines and refrigerated units for thermal preservation of samples (EPA 2010).

Ocean Survey Vessel *Bold* photographed March 2010
(*photo courtesy, Richard Klain*)

Sampling equipment aboard the *Bold* was used to collect sediment, water, in situ water column readings, benthic infauna, trawled epifauna, and tissue samples. ANAMAR, EPA, and FLMNH provided additional equipment such as containers, chemicals, and handling equipment for use with various samples.

Sediment and benthic infaunal samples were collected during the morning and afternoon of May 3, 2011. Epifaunal sampling was conducted during the morning, afternoon, and late evening of May 4, and the very early morning, afternoon, and late evening of May 5, 2011, including some additional tows used to collect additional tissue mass. Water column profile recordings and water sampling were conducted during the late morning of May 5, 2011. A synopsis of the survey schedule and activities can be found in the report titled *Port Everglades Harbor ODMDS Expansion Designation Survey* by McArthur (2011), provided in Appendix E. A brief timeline of the survey is offered in the following table.

Daily Activities during the May 2011 Site Expansion Survey

Date	General Activities Performed	Stations Sampled
May-2-2011	Mobilization: field team members embarked ship at a berth along Pier 27 at Port Everglades Harbor, Fort Lauderdale, FL. Equipment and supplies were loaded and organized on the ship. Equipment was decontaminated using proper procedures.	Not Applicable
May-3-2011	Ship left the dock. Personnel underwent safety and science briefings. Sediment and infaunal samples were collected from in and around the expansion areas.	Sediment: PE11-1 through PE11-5 Infauna: PE11-1 through PE11-5
May-4-2011	Conducted epifaunal trawls in and around the expansion areas.	Trawls: PE11-5 (experimental trawl), PE11-8 (day and night), and PE11-9 (day and night)
May-5-2011	Conducted epifaunal trawls and CTD-profile recordings and collected water samples in and around the expansion areas. Extracted all epifaunal invertebrate and fish tissues necessary for bioaccumulation analysis.	CTD-profiler: PE11-6 and PE11-7 Water: PE11-6 (4 depths sampled) Trawls: PE11-6 (day and night), PE11-7 (day and night), PE11-5 (tissue only), PE11-10 (tissue only), PE11-13 (tissue only), and PE11-14 (tissue only)
May-6-2011	Team members re-packed and organized equipment and personal gear and disembarked the ship. Samples were carefully packed for travel.	Not Applicable

2.4 Sampling and Handling Methods

Sampling was conducted according to published guidance. General field methods and procedures include those outlined in the Green Book (USACE and EPA 1991) and the Florida Department of Environmental Protection *Standard Operating Procedures for Field Activities* (Florida Department of Environmental Protection 2008). Quality assurance and quality control (QA/QC) procedures were based on those described in EPA (1995). Sediment collection and storage procedures were based on those described in EPA (2001). Epifaunal and infaunal sampling materials and methods were based on those described in Pequegnat et al. (1990). General sampling operations are photo-documented in Figure 1.

2.4.1 Navigation and Positioning Control

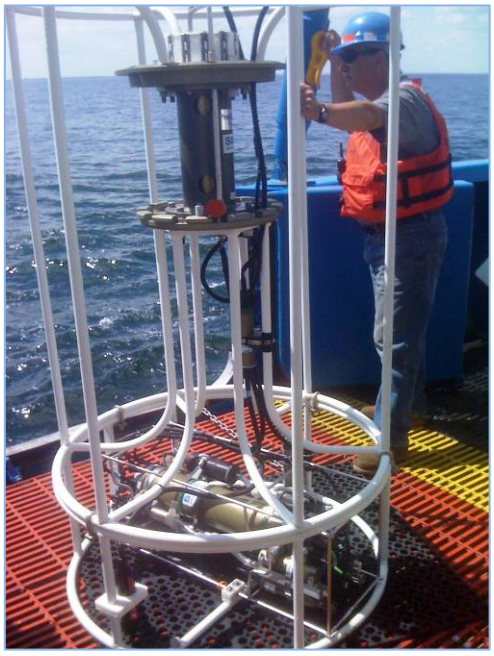
Navigation and vessel positioning was handled by the captain of the *Bold* with consultation from the chief scientist, as needed.

Spatial coordinates and water depths were recorded during sampling using Hypack and Nobeltec software in conjunction with a differential GPS, and each sample name and description was logged in Hypack. During epifaunal sampling, an offset was used from the ship's position to account for layback of the trawl. Target station coordinates are provided in Tables 10-1 through 10-5 of the Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP) document (Appendix A).

In situ water data obtained via the CTD profiler were taken within a 200-meter radius of each station location. For sediment and infaunal samples, actual sampling locations were within a 50-meter radius of each respective station. If a sample was collected off-target, it was discarded and noted as-such in Hypack. Epifaunal trawl transect starting points (i.e., when the gear first reached the seafloor) or ending points (when the gear lifted off the seafloor) were generally within 200 meters of each station. Coordinates were logged in Hypack at the beginning and ending of each tow. Trawls were towed against the Florida Current for optimal performance and ship maneuverability. Tables 1 through 4 contain coordinates, dates, times, water depths, and field observations recorded during CTD-profiler deployments as well as during sampling of water, sediment, benthic infauna, and trawled epifauna.

2.4.2 In Situ Water Profiling

A Sea-Bird SBE 9 CTD profiler supplied by EPA and maintained onboard the OSV *Bold* was used to record continuous water column parameters consisting of depth, temperature, salinity, dissolved oxygen, turbidity, and PAR. Probes were calibrated according to OSV *Bold* standard operating procedures (SOP). While on-station, the ship was held in position by dual propellers and bow thrusters as needed. The CTD profiler was then slowly lowered into the water from the starboard side of the ship using a small crane, integrated electronics-and-tow cable, and a winch. The integrated cable allowed real-time data monitoring, and the information was recorded on shipboard computers. These data later underwent post-processing and analysis at ANAMAR headquarters.



CTD-profiler prior to deployment

A single profile was taken at each of Stations PE11-6 and PE11-7 for a total of two profiles recorded (Map 1). Table 2 provides coordinates, dates, times, and depths of CTD-profiler deployments.

Station locations were chosen to better understand the effects of the Florida Current on the existing ODMDS and surrounding area. Any stratification of temperature, salinity, dissolved oxygen, or density detected during monitoring of real-time data was recorded on a field sheet. These data provided information on vertical movement as well as layering of the water column. Conditions such as the presence or absence of a thermocline (zone of maximum rate of

decrease of temperature with increasing depth), isotherm (zone of little or no temperature change with depth), or halocline (a zone of rapid salinity changes) can be elucidated using water profile data. Copies of the CTD-profiler field sheets are provided in Appendix B.

2.4.3 Water Physical Sampling

Water physical samples were collected during the May 2011 survey using four 10-liter Niskin bottles mounted on a rosette carousel surrounding the CTD-profiler unit. At Station PE11-6, water was collected at approximately 16.4 feet from the surface, 213.2 feet below the surface (within a thermocline), 410 feet below the surface (within an isothermic layer), and 623.2 feet below the surface (near the seafloor) during a single CTD-profiler deployment. During this deployment, one Niskin bottle was remotely triggered at each chosen depth. The Niskin bottles allowed more than sufficient water volume (10 liters per sample) needed for analysis. Thus, four samples were collected from this station plus one field split sample. The field split sample was given a different name than the native sample to ensure that the origin could not be discerned by the laboratory conducting the analysis. Although only two liters of water were needed for analysis by Columbia Analytical Services (CAS) of Kelso, Washington, three liters were collected per sample (one liter was archived at ANAMAR). In the case of the field split sample, six liters were collected to allow for the field split. Water sample data and associated CTD-profile information were recorded on the same field log. Copies of field logs are provided in Appendix B. Information recorded on field logs included sample ID, sampling personnel, date and time, collection method, sample containers, water depth, and other field observations.

Prior to mobilization, the inner surface of each Niskin bottle was decontaminated using a method modified from those described in Florida Department of Environmental Protection Standard Operating Procedures FC1000. Each bottle was scrubbed using a solution of Liquinox® and site water, thoroughly rinsed with deionized water, and allowed to dry. Personnel decontaminating the bottles, handling the Niskin bottle spouts, and filling sample containers wore disposable nitrile gloves. Nitrile gloves were replaced with a new pair during each handling. Pre-washed glass sample jars with waterproof labels and Teflon® lid liners were supplied by ANAMAR for water sample containment.

Deploying CTD-profiler with attached 10-liter Niskin bottles

Pertinent data were written on jar labels using a Rite in the Rain® pen, and the sample containers were immediately placed in a refrigerator for thermal preservation at 4° ± 1°C. The containerized samples were kept in ice-filled coolers during transport in an insulated trailer to ANAMAR headquarters where the samples were prepared for shipment to CAS on May 9, 2011. A chain-of-custody form was filled out with sample IDs, date and time of collection, and required analyses and accompanied the samples during transport to the laboratory. A copy of the chain-of-custody form is provided in Appendix F. Samples were shipped overnight air via FedEx to CAS. Upon arrival at CAS, samples were logged in; assigned a unique laboratory

ID number; and stored, handled, processed, and analyzed as described in applicable quality assurance manuals and CAS SOPs.

2.4.4 Sediment Chemical and Physical Sampling

A van Veen grab sampler and associated stability frame was used to collect sediment samples for physical and chemical analysis. This device samples a sediment surface area of approximately 0.1 m^2. The sampler was deployed by a winch, galvanized steel cable, and a hydraulically operated A-frame from the stern of the ship. ANAMAR, EPA, and USACE personnel helped *Bold* crew members deploy and retrieve the sampler. A watch stander recorded coordinates and water depth of each sample location using Hypack and noted whether the resultant sample was acceptable or if it was discarded. The electronic records logged in Hypack complemented those notes written on field sheets. Copies of sediment field sheets can be found in Appendix B, along with field photographs. Sediment sampling coordinates and field observations are given in Table 1.

Once on-deck, the sample was inspected for signs of leakage, winnowing, overfill, or disturbance. The sample was discarded and the station re-sampled if any of these conditions were observed or if the sample was collected off-station (>50 meters from target location). If the sample was acceptable, the sediment was then allowed to fall out of the mouth of the van Veen and into a pre-cleaned stainless steel bin. A single grab sample was collected per station; this method allowed enough volume for required analyses, including the field split sample. The field split sample was given a different name from the native sample to ensure the origin could not be discerned by the laboratories. Decontaminated stainless-steel spoons and bins were used for homogenizing each sample. Photographs of samples were taken while sediment was still in the grab sampler as well as before and after homogenization. Sediment sample photographs can be found in Appendix B; general sampling operations are photo-documented in Figure 1. Three 950-ml wide-mouth pre-cleaned glass jars with Teflon® lid liners were filled with homogenized sediment from each station—two jars for laboratory analysis and one jar for archiving at ANAMAR. All sample jars used for chemical analysis were obtained from C & G Containers, Inc. (Lafayette, Louisiana) after being cleaned using a protocol which included cycle washing with deionized water, cycle rinsing with 1:1 nitric acid, additional washing with deionized water, and oven drying. In addition to the jars, a 3.8-liter Ziploc® bag was filled half-way with sediment for physical analysis. Sediment color, texture, and odor were noted on log sheets along with other sample-related information. Jars of sediment samples were labeled, placed on ice, and later stored at 4°C ± 1°C in a refrigerator onboard the *Bold*.

Sediment sample in van Veen grab sampler

Copies of temperature log sheets are provided in Appendix B. Samples slated for physical analysis were double-bagged, labeled, and kept at ambient temperature.

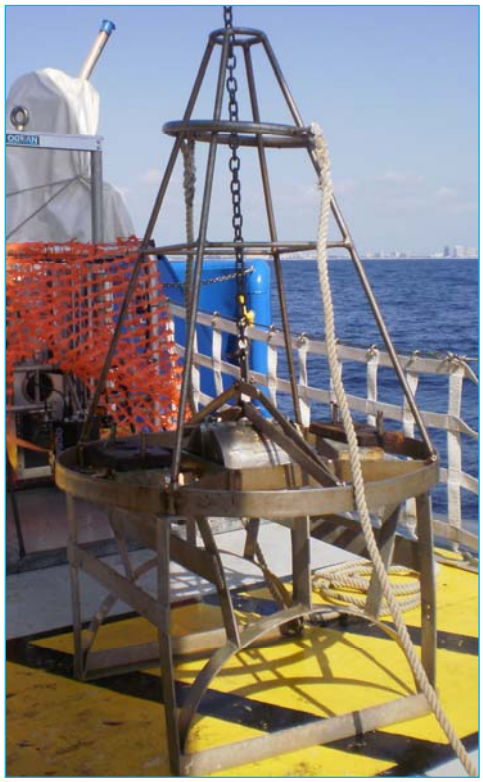
Equipment contacting sediment chemistry samples was cleaned and decontaminated before and between sampling stations. Decontamination procedures followed those outlined in FC1000. Personnel handling sediment chemistry samples and decontaminating equipment wore disposable nitrile gloves. Although contact between gloves and the sample was strictly avoided, the nitrile gloves were changed between sampling locations to prevent cross-contamination.

Sediment samples were collected at two stations within the expansion areas and one station within the existing ODMDS. Two stations outside (north and south) of the expansion areas were sampled. This spatial methodology follows recommendations stated in the guidance documents.

Upon completion of the survey, sediment samples slated for chemical analysis were packed in ice-filled coolers and transported to ANAMAR headquarters. Samples for physical analyses were transported at ambient temperature. The samples were stored at ANAMAR headquarters in a refrigerator at 4° ± 1°C before shipment to the laboratories on May 9, 2011. Chain-of-custody forms were filled out with sample IDs, date and time of collection, and required analyses and accompanied the samples during transport to the laboratories. Copies of chain-of-custody forms are provided in Appendices F and G. Samples were shipped via FedEx Ground to MACTEC Engineering and Consulting, Inc. (recently purchased by AMEC) in Jacksonville, Florida, for physical testing and via FedEx Express overnight service to CAS for chemical analysis. Upon arrival at the laboratories, samples were logged in; assigned a unique laboratory ID number; and stored, handled, processed, and analyzed as described in applicable quality assurance manuals and SOPs of the testing laboratories.

2.4.5 Benthic Infaunal Sampling

A Young-modified van Veen grab sampler (or Young grab) was used to collect sediment samples for infaunal analysis. This device samples a sediment surface area of approximately 0.04 m^2, penetrates to a maximum depth of 10 cm, and has an internal volume of approximately 3.8 liters. The Young-modified van Veen compares well with the standard van Veen in terms of infaunal sampling efficiency and the ability to replicate samples as long as it is handled skillfully and during fair weather (Lie and Pamatmat 1965). The sampler was deployed using a winch and galvanized steel cable from the stern of the ship. A hydraulically operated A-frame allowed the grab sampler to be maneuvered between the back deck and the water. Members of the survey team assisted *Bold* crew members in deploying and retrieving the sampler. A watch stander recorded coordinates and water depth of each sample location using Hypack and noted whether the resultant sample was acceptable or if it was discarded. The electronic records logged in Hypack complemented those notes written on field sheets.



Young-modified van Veen with stability frame resting on stand

Information recorded on field sheets included sample ID, sampling personnel, date and time, collection method, sample containers, sediment description, and water depth. Appendix B contains copies of these field sheets; a summary of field observations and sampling coordinates is presented in Table 3.

Once on deck, the sample was inspected for signs of leakage from the grab sampler. If the sampler was determined to be lacking in volume or if the sample was collected off-station (>50 meters from target locality), the sample was discarded and another attempt was made. One grab was collected for each sample replicate and three replicate samples were taken per station. Acceptable samples were photographed and the entire volume of sediment was extracted from the grab sampler and placed into a stainless steel bin. A squirt bottle was employed to wash residual sediment from the inside of the grab. Samples were again photographed while in the stainless steel bin before sieving. Infaunal sample photographs are in Appendix B.

Each sample was then transferred into a standard U.S. #35 (0.5-mm mesh size) sieve bucket and wet-sieved until all particles smaller than 0.5 mm passed through the screen. Remaining sediment and invertebrates were then washed into a Hubco geological sample bag containing a waterproof label, and the bag was secured at the opening with twine. An additional waterproof tag, stitched at the seam of each cloth bag, was also filled out. A No. 1 (soft, dark graphite) pencil was used to fill out labels. Sample bags were placed into an 18.9-liter plastic bucket containing undiluted NOTOXhisto® (a fixative). Buckets were labeled as to sample contents.

Samples were taken in triplicate from each of five stations (15 total replicate samples). Two stations within the expansion areas, one station within the existing ODMDS, and two stations outside (north and south) of the expansion areas were sampled for infauna. The spatial positioning of the stations in relation to the Florida Current combined with the number of stations sampled ensured compliance with the guidance documents.

Infaunal samples remained submerged in NOTOXhisto® fixative inside an 18.9-liter plastic bucket during transport to ANAMAR headquarters. The samples were prepared for shipping on May 10, 2011, via FedEx Ground to Barry A. Vittor & Associates in Mobile, Alabama. A chain-of-custody form was filled in with sample IDs, date and time of collection, and required analyses and accompanied the samples during transport to the laboratory. A copy of the chain-of-custody form is provided in Appendix D. Upon arrival at the laboratory, samples were logged in; assigned a unique laboratory ID number; and stored, handled, processed, and analyzed as described in applicable quality assurance manuals and SOPs of the Barry Vittor laboratory.

2.4.6 Epifaunal Sampling

Epibenthic invertebrates and demersal fishes were gathered using an otter trawl and the OSV *Bold*. Wound galvanized steel cable was attached to a large drum winch and fed through a block attached to a hydraulic A-frame to provide an umbilicus between the ship and the trawl. The ratio of cable length to water depth varied from an estimated 4:1 (38% of tows) to 5:1 (62% of tows), not counting a trial tow, in addition to the bridle length. Cable length was estimated to be about 200 meters per layer on the drum winch and the number of cable layers used was monitored to estimate scope. A deck winch was used to raise the trawl from the water and onto the stern deck. The otter trawl measured 7.3 meters in width, had 27-mm stretch mesh towards the front of the net, and a 20-mm stretch mesh liner in the bag end. A

stainless steel chain was attached to the foot rope using cable ties. A stainless steel 'tickle chain' was also used. Contact with the seafloor was difficult to discern from wear of the otter doors as much of the original corrosion remained visible on the steel feet throughout the survey. Based on trawl sample contents (e.g., rocks, trash, benthic fauna), the trawl contacted the seafloor during at least a portion of each tow.

Prior to the survey, a letter of acknowledgement was obtained from National Marine Fisheries Service (NMFS) (Appendix C) which allowed limited scientific collection of certain South Atlantic Fishery Management Council (SAFMC)-managed invertebrates and fishes during the survey in accordance with the definitions and guidance of 50 CFR §600.10 and §600.745. Copies of the acknowledgement letter and the survey plan were kept onboard the vessel.

Four stations were sampled during the May 2011 survey, with two stations sampled inside the expansion areas and two stations sampled south and west of these areas (Map 1), not counting a trial tow and tissue-only tows. Each station was sampled by day and after dark to account for diel changes in epifaunal activity patterns. The day and night sampling maximized biodiversity of catch and provided the best indication of epibenthic community structure within the time constraints of the survey. Station selection and other aspects of epifaunal sampling followed Pequegnat et al. (1990). Spatial coordinates were recorded at the beginning and ending of each tow using Hypack and Nobeltec software with an offset from the ship's position to account for layback of the trawl (Table 4). Bottom time per tow averaged 16.5 minutes but ranged from 14 to 21 minutes. Tow speed over ground ranged from 1.1 to 1.8 knots, and transect lengths varied from 0.252 to 0.444 nmi. Tows were conducted against the Florida Current to maximize trawl performance and ship maneuverability. Efforts were made to avoid overlapping transects (Map 1).

Upon completion of each tow, specimens were carefully removed from the trawl. Wet weight was recorded separately for invertebrates and fishes from each sample using an 18.9-liter plastic bucket with drain holes and hanging Macro Line scales (5-kg and 20-kg) accurate to within 0.3% of maximum weight. Organisms were sorted, tentatively identified, and enumerated onboard the ship by an ANAMAR biologist and two FLMNH workers, with help from watch standers. A subsample of each fish species and selected invertebrates from each trawl were measured to the nearest millimeter using rulers or a measuring board. Subsamples of invertebrate taxa were placed in a relaxant (a solution of tap water and either magnesium chloride or clove oil), preserved in 75% ethanol, and sealed in Whirl-Pak® bags for later study. Subsamples of most fish species were placed in Ziploc® bags containing a 10% buffered formalin solution for later verification of identity. Some larger crabs and fishes were

7.3-meter-wide otter trawl on stern deck

bagged and kept frozen. Most taxa were photographed while fresh. Invertebrate photographs were taken by FLMNH workers using a Nikon® D70 or D90 digital single-lens-reflex camera, black non-reflective photo background, multiple stationary flash units, and a small glass tank. Fish photographs were taken by an ANAMAR biologist using a neutral-colored non-reflective photo background, a Canon PowerShot SX110IS digital camera, and diffuse incandescent and natural lighting. Photographs of selected epifaunal taxa are presented in Figure 13. Electronic image files are contained within Appendix B along with copies of the project-specific field sheets. Remaining epifauna were released after data collection.

Retained specimens remained in preservative inside containers during vehicle transport to Gainesville, Florida. Large crabs and fishes remained bagged and on ice in coolers during transport. Invertebrates were transported to the FLMNH for final taxonomic determination by specialists and to be accessioned into the FLMNH Division of Invertebrate Zoology collection. Fish specimens were taken to ANAMAR headquarters for final determination of species and were later deposited at the FLMNH.

2.4.7 Epifaunal Tissue Sampling

A total of six tissue samples (invertebrates and fishes) plus one field split sample were taken from epifaunal catches during the May 2011 survey. Taxa were selected for tissue analysis based on criteria given in Pequegnat et al. (1990), along with known life history traits, edibility by U.S. consumers, availability, typical amount of edible tissue, and degree of site specificity. It was necessary for taxa to have benthic to epibenthic habits most of their lives as it is assumed that such taxa are likely affected by sediment contamination. Tissue-sampled taxa must also regularly appear in trawl catches to allow sufficient tissue to be obtained at multiple stations to be used in comparisons. Selection of suitable taxa was limited by the availability of such taxa in trawl samples. Recent advances in bioaccumulation analysis requiring only very small amounts of tissue (e.g., 100 to 200 mg wet weight), termed 'microscale' methods (Jones et al. 2006, Millward et al. 2007, G. Lotufo *pers. comm.*), may be a viable option for future studies as microscale methods eventually become adopted by more laboratories. The use of microscale methods would significantly increase the number of field taxa suitable for tissue analysis as mass will be much less of a consideration.

Trawl-caught taxa deemed acceptable for tissue sampling consisted of the bathyal swimming crab (*Bathynectes longispina*), Jonah crab (*Cancer borealis*), rosette skate (*Leucoraja garmani*), spotted hake (*Urophycis regia*), and fourspot flounder (*Paralichthys oblongus*). Although there are currently no known fisheries for the bathyal swimming crab, it is likely to be edible and suitable for human consumption based on the edibility of other large crab species. The spotted hake was considered for tissue analysis due to the availability of specimens in trawl catches along with the species' demersal habits, edibility, and interest by fisheries despite the known seasonal movement patterns of juvenile and mature spotted hake and the use of estuaries by juveniles (Iwamoto 2002, Klein-MacPhee 2002). The benthic-feeding Jonah crab, like other *Cancer* crabs, does not appear to undertake long migrations (Pequegnat et al. 1990), and therefore any contaminants of concern found in the tissue of this species are likely to have originated from within a relatively small area.

Methods and materials used followed the guidance of Pequegnat et al. (1990), but differed in terms of the mass needed for analysis and in the use of pre-cleaned 180-ml glass jars with Teflon® lid liners instead of aluminum foil sheets. Methods also differed from those stated in

Pequegnat et al. (1990) in that muscle tissue was extracted in the field rather than shipping the whole specimens to the lab frozen. Field extraction was done to ensure adequate mass for analysis and to avoid contamination of the muscle tissue by organ tissue when cells lyse during the freezing and thawing processes. Equipment contacting tissue samples was first cleaned and decontaminated as described in FC1000. Stainless steel fillet knives were used to extract muscle tissue from hake. Stainless steel scalpels, forceps, and pliers were used to extract muscle tissue from crab. The minimum sample amount required by CAS was 4 grams for metals analysis and 10 grams each for polynuclear aromatic hydrocarbons (PAHs), organochlorine pesticides, organotins, and polychlorinated biphenyl (PCB) congeners. Muscle tissue from multiple individuals of a given taxa and station were combined to achieve adequate mass. Adequate mass was obtained to perform laboratory QA/QC (matrix spike and duplicate matrix spike analysis) of each analyte.

Upon extraction of tissue (i.e., leg muscle of crab, fillet of fish), each sample was wrapped in a portion of pre-cleaned Teflon® bag and weighed wet using a tared 100-gram Micro Line hanging scale with accuracy to within 0.3% maximum weight. Information was recorded on a tissue data sheet (Appendix B). After being photo-documented, the sample was placed into a labeled 180-ml pre-cleaned glass jar with a Teflon® lid liner and stored in a freezer onboard the ship. Upon conclusion of the survey, samples were packed in an ice-filled cooler for transport to ANAMAR headquarters. Samples were then stored in a freezer for later overnight shipment via FedEx Express to the CAS laboratory on May 9, 2011.

Tissue extracted from 17 spotted hake (*Urophycis regia*) prior to containerizing sample

Tissue extracted from four Jonah crabs (*Cancer borealis*) prior to containerizing sample

3 ANALYTICAL AND STATISTICAL METHODS

For each parameter, comparisons between stations and in relation to the expansion areas are summarized and discussed in Section 4 (Results and Discussion) and in figures and tables.

3.1 Water Profile and Physical Analyses

Post-processing of CTD-profiler data was facilitated with Sea-Bird Electronics Data Processing® software (part of the Seasoft V2 software suite) and Microsoft Excel. Bin averaging was set at every 16.4 feet (5 m), although the same data were also averaged every 32.8 feet (10 m) to allow smaller tabulated datasets. An equation was applied during post-processing to take into account a 64-inch difference in elevation between the PAR sensor mounting and that of the depth sensor on the CTD-profiler housing. Normalized PAR was calculated by dividing the submarine PAR by the surface PAR and multiplying the product by 100. The maximum depth of the photic zone (defined here as greater than or equal to 2% of surface PAR values) was identified in each water profile. Along with the site characterization discussed in Section 4.2 (Water Profile and Physical Results), these data could also be used in future Automated Dredging and Disposal Alternatives Modeling System Simulations and for dredged material disposal events to document compliance with EPA marine water quality criteria and limiting permissible concentration.

Water physical analysis was performed by CAS and consisted of total suspended solids using a Method 160.1 established by EPA. The analysis of chemical parameters in water samples was not necessary as a thorough investigation was performed on water sampled in April 1998 and October 2007 and results were given in EPA (1999) and ANAMAR (2010), respectively. Analytical results of the April 1998 sediment samples indicated that most analyte concentrations were below detection levels. Wet weight concentrations of total suspended solids are presented and discussed in Section 4.2 (Water Profile and Physical Results) of this report. Dry weight results are included in Appendix F only. No published criteria maximum concentration (CMC) or criterion continuous concentration (CCC) values currently exist for total suspended solids (EPA 2006, Buchman 2008).

3.2 Sediment Physical and Chemical Analyses

3.2.1 Physical Analyses

Sediment physical analyses were performed by MACTEC using methods ASTM D-422 and ASTM D-1140 for grain-size analysis and ASTM D-2216-80 for total solids (Plumb 1981). Grain-size distributions included a graph of the cumulative frequency percentages using USACE Form 2087. ANAMAR performed QA/QC on sediment data, tabulated physical data by sampled station, and graphed the grain-size distribution by station.

3.2.2 Chemical Analyses

CAS conducted the chemical analyses of sediment samples. Various metals, total organic carbon, organochlorine pesticides, semi-volatile compounds, PCB congeners, PAHs, and organotins were analyzed using standard methods listed in the SERIM. Some analytes that are not listed as standard contaminants of concern in the SERIM (e.g., Mirex®, certain dichlorodiphenyltrichloroethane [DDT] derivatives) were tested using SERIM-listed test methods. The CAS lab used a reductive precipitation procedure for metals analysis, which

reduced the interference of salts. ANAMAR reduced the data, performed QA/QC, and compiled and presented the results.

The main objective of the sediment physical and chemical analyses is to allow comparisons of characteristics and analyte concentrations between stations inside the proposed expansion areas to those outside the areas. These comparisons are intended for reference use only and are not intended for regulatory decisions. The sediment chemical concentration, method detection limit (MDL), and method reporting limit (MRL) were reported on a dry weight basis. The MDL refers to the minimum concentration of a given analyte that can be measured and reported with a 99% confidence level that the analyte concentration is greater than zero (40 CFR §136 Appendix B). The MRL refers to the minimum concentration that the laboratory will report analytical chemistry data with confidence in quantitative accuracy of a given data. Common laboratory procedures for defining an MRL include assigning it to a fixed factor above the MDL or by using the lowest calibration standard. MRLs are often adjusted by the laboratory for sample-specific parameters such as sample weight, percent solids, or dilution.

ANAMAR also compared the resultant sediment chemical analytical data to published sediment screening values as appropriate and in conformance with the Green Book (EPA and USACE 1991) and the SERIM. These levels are the threshold effects level (TEL), effects range-low (ERL), and apparent effects threshold (AET). The TEL represents the concentration below which adverse effects are expected to occur only rarely. The ERL is the value at which toxicity may begin to be observed in sensitive species (Buchman 2008). The AET represents the concentration above which adverse biological impacts would always be expected due to exposure to the contaminant alone (Buchman 2008).

3.3 Benthic Infaunal Analyses

Biological characterization of benthic infauna was performed by Barry A. Vittor & Associates, Inc. (see Appendix D for report). Tasks included sorting, identifying, enumerating, and calculating wet weight biomass of invertebrate organisms collected at each station (see Barry Vittor & Associates [2004] for further details). Invertebrates were identified to the lowest practical taxonomic level and a phylogenetic list was compiled. Data quality objectives for enumeration and taxonomy of invertebrates are summarized in Table 7-2 of the SAP/QAPP (Appendix A).

The following numerical data were calculated for comparisons between stations and in relation to the expansion areas:

- Taxonomic richness (mean taxa per station)
- Infaunal abundance (total number of individuals per station)
- Taxonomic diversity (Shannon diversity index)
- Taxonomic evenness (Pielou evenness index)
- Brief comparisons with previous studies

See Türkman and Kazanci (2010) for equations of the indices mentioned above. Barry Vittor & Associates performed data analyses using approaches designed to identify differences in community structure between pooled samples, such as between stations and in relation to the expansion areas. They also conducted a cluster analysis and a multidimensional scaling (MDS) analysis to ascertain the similarities in infaunal parameters between the five stations sampled.

Data interpretation consisted of benthic community characterization, including faunal composition, abundance, community structure, and comparisons with past surveys.

3.4 Epifaunal Analyses

Invertebrates captured by trawl were identified to the lowest practical level by an ANAMAR biologist with help from FLMNH invertebrate specialists, and representative specimens of many species are slated to be accessioned into the invertebrate zoology collection. Invertebrates were preserved in 75% ethanol or 10% buffered formalin while fish specimens were fixed in 10% buffered formalin and later rinsed and preserved in 70% ethanol for long-term storage. Fishes were identified to the species level by an ANAMAR biologist. A combination of taxonomic keys, comparison with preserved specimens, and consultation with taxonomists helped verify determinations. Microscopes were used to observe characteristics of smaller invertebrates and fishes. Representative fish specimens were then donated to the FLMNH ichthyology collection. An ANAMAR biologist dissected selected retained fishes when time permitted. Gut content and maturity data obtained during dissections helped assess the function and importance of certain species in and around the expansion areas. Dissection results are included in Section 4.6.5 (Community Structure Based on Trawl Catches). Appendix H consists of notes made during dissections.

Pooled trawl sample data were compared between stations as well as between the proposed expansion areas and stations outside these areas. In many analyses, data were normalized by converting to amount (of a given parameter) per 1,000 m^2 of sampled area, which greatly reduced variability caused by tow speed and tow duration. Focal attributes of interest are listed below.

- Area sampled per tow (in square meters)
- Phylogenetic lists of captured invertebrates and fishes
- Local population densities of abundant species
- Wet weight invertebrate and fish biomass
- Densities of epifauna by major taxonomic groups
- Taxonomic richness (Margalef richness index)
- Taxonomic diversity (Shannon diversity index)
- Taxonomic evenness (Pielou evenness index)
- Community composition and brief habitat characterization
- Species of federal management interest
- Nonindigenous species (if present)
- Brief comparisons with previous studies

3.5 Epifaunal Tissue Analyses

CAS conducted chemical analyses of all epifaunal tissue samples. Just as in sediment analyses, CAS used a reductive precipitation procedure to reduce the interferences from salts for metals in tissue. Results of epifaunal tissue sample analyses were reported by CAS in both wet and dry weight basis. In this report, only wet weight data are summarized. In general, focal analytes were those suggested in Pequegnat et al. (1990), with the addition of organotins. Organotins are contaminants of concern in the Port Everglades Harbor area and are therefore included in the present study. Pequegnat et al. (1990) suggests the investigation of the petroleum hydrocarbons group. The petroleum hydrocarbons analyzed and discussed in this report are those specified in the SERIM and the Green Book. Although the SERIM suggests

analysis of the semi-volatile substance pentachlorophenol in tissue, this analyte was not of concern in the present study and is not suggested for tissue testing in Pequegnat et al. (1990); therefore, it was omitted here. Standard SERIM methods were used for the analysis of metals, organochlorine pesticides, PCB congeners, PAHs, and organotins. The SERIM lists the organotin analytical method as 'Krone et al., 1989' (but lacks the full citation in the References section). This procedure uses a 0.1% tropolone in methylene chloride extraction of the analytes of interest from an acidified sample, followed by a Grignard reaction of the hexane extract with hexylmagnesium bromide (Krone et al. 1989). The extract is then eluted through silica and alumina cartridge columns for cleanup of soil extracts, or through Florisil® columns for cleanup of tissue extracts, then analyzed by gas chromatograph and flame photometric detection of organotins with a 610-nm bandwidth filter (Krone et al. 1989). Laboratory QA/QC was performed on each analyte in the form of matrix spike and duplicate matrix spike analysis. Total solids were analyzed and given as a percentage. Lipid concentrations were also analyzed, as the potential bioaccumulation of nonpolar organic chemicals can be estimated from the lipid content of an organism. Such lipid data could later be used in theoretical bioaccumulation potential calculations (Green Book) or in modeling programs such as TrophicTrace (Bridges and von Stackelberg 2003).

As with sediment and water analyses, ANAMAR reduced the tissue data, performed QA/QC and compiled and compared the results to published tissue screening values suggested by USACE and EPA. The U.S. Food and Drug Administration (FDA) crustacea action level was used as it is applicable with crab sample analysis results. Most FDA levels were obtained from Appendix H of the SERIM and the decimal places were preserved from the source document whenever a discrepancy was found between the SERIM and FDA (2001). In light of additional discrepancies found in the SERIM for FDA action levels for tissue concentrations of cadmium, DDT derivatives, and Mirex®, the FDA levels of these analytes were obtained instead from FDA (2001). According to FDA (2011) the action levels for arsenic, cadmium, lead, and nickel are no longer in effect. Regardless, it was decided to use these levels in this report as similar levels for these contaminants could be put into effect in the near future. It was decided not to use the ecological non-specific effects thresholds or the EPA Region 4 eastern Florida background concentrations for polychaetes or bivalves since these thresholds were not applicable to the taxa sampled herein. Only a few FDA levels are currently available for fish bioaccumulation concentrations and these were compared with the fish results whenever applicable. Additional published comparison data were identified by searching the USACE/EPA Environmental Residue-effects Database (http://el.erdc.usace.army.mil/ered/) and the EPA National Service Center for Environmental Publications (http://www.epa.gov/nscep/), and by conducting an additional literature search via the Academic Search Premier database through the University of Florida library system.

The main objective of the tissue chemistry analyses is to allow comparisons of characteristics and analyte concentration levels between stations and between samples taken from within the expansion areas and those taken outside the areas. A secondary objective is to provide a baseline for comparisons of future monitoring results. These comparisons are intended for reference use only and are not intended for use in making regulatory decisions.

4 RESULTS AND DISCUSSION

4.1 Field Data

Conditions during the May 3 through 5, 2011, sampling days were favorable and consisted mainly of clear to partly cloudy skies, 0- to 15-knot winds (0 to 4 on the Beaufort scale), and 1- to 4-foot seas. Rain occurred during the afternoon on May 5. All sampling was conducted while being directly affected by the Florida Current flowing south to north at a fairly constant speed. Given the size of the OSV *Bold*, even 4- to 5-foot seas did not significantly affect the success of sampling efforts. Water temperatures ranged from 8.1° (near-bottom) to 26.7°C (near-surface) based on CTD-profiler results. April 2011 air temperatures in Fort Lauderdale ranged from a low of 19° to a high of 32°C, and monthly precipitation totaled 32.8 cm (The Weather Channel 2011).

4.2 Water Profile and Physical Results (Tables 5–7, Figure 2, Appendix F)

Water column profiles were obtained using a CTD profiler at Stations PE11-6 and PE11-7 (located within the expansion areas) during late morning on May 5, 2011 in water 623.2 to 721.6 feet deep during ebb tide. Dissolved oxygen, salinity, temperature, turbidity, and PAR were recorded throughout the water column at each station. PAR is an important gauge for biological and ecological studies as it indicates the total light energy available for photosynthesis by phytoplankton and macrophytes. Data were bin-averaged every 16.4-feet of water depth in Tables 5 and 6, while 32.8-foot bin averaging was used for the summary tables included below. In order to obtain accurate PAR readings at the surface, a separate bin average set at 69 inches was calculated to account for the difference in elevation between the PAR sensor mounting and that of the depth sensor on the CTD-profiler housing. The two stations exhibited very similar water column parameters and are discussed together below. Figure 2 contains separate plots for each measured parameter per station.

Temperature ranged from a low of 8.1°C at Station PE11-7 near the seafloor at about 722 feet deep to a high of 26.7°C in an isothermic layer extending from the water's surface to about 70 feet deep at both stations. A second isothermal layer was observed in approximately 377 to 426 feet of water in the Station PE11-6 profile, but this layer showed a slight temperature change (0.1°C per 16 feet) in the PE11-7 profile recording. Temperature changed an average of about 0.4°C per 16 feet of water depth at both stations. A thermocline of 1.0°C or more temperature decrease per 16 feet was observed between about 180 and 280 feet deep at both stations, although recordings taken during ascent (up-cast) showed this layer to be at a somewhat shallower depth than in recordings made during descent (down-cast).

Dissolved oxygen ranged from a low of 4.2 mg/L within about 100 feet of the bottom to a high of 7.3 mg/L at about 180 feet below the surface at both stations. Salinity remained fairly constant, ranging from a low of 35.0 ppt to a high of 36.4 ppt at both stations. No haloclines were observed. Turbidity ranged from a low of 0.1 FTU (clear water) within the upper water layers at both stations to a high of 1.8 FTU at Station PE11-7 near the water's surface.

PAR was measured at depth, and a corresponding reading was taken at the surface. The ratio of these two values was calculated to determine normalized PAR. Normalized PAR remained above 2% within approximately 200 feet of the water's surface at both stations. The following

two summary tables present water column recordings at Stations PE11-6 and PE11-7 using 32.8-foot bin averaging. Water data was bin averaged every 16.4-feet of water depth in Tables 5 and 6.

CTD-Profile Parameters taken May 2011 from Station PE11-6*						
Depth		**Range of Parameters**				
Feet	**Meters**	**Dissolved Oxygen (mg/L)**	**Salinity (ppt)**	**Temperature (°C)**	**Turbidity (FTU)**	**Normalized PAR (%)**
Descent						
0.0	0	6.6	36.2	***26.7***	0.3	***49.6***
32.8	10	6.7	36.2	***26.7***	**0.1**	29.7
65.6	20	6.7	36.2	***26.7***	**0.1**	20.2
98.4	30	6.8	36.2	26.5	**0.1**	14.8
131.2	40	6.9	***36.3***	25.9	**0.1**	9.7
164.0	50	***7.1***	***36.3***	24.7	0.2	6.0
196.8	60	7.0	36.2	22.0	***0.4***	2.5
229.6	70	6.5	36.2	19.5	0.3	0.9
262.4	80	5.7	36.0	16.9	0.2	0.5
295.2	90	5.1	35.9	15.3	0.3	0.4
328.0	100	4.5	35.8	14.2	0.2	0.4
360.8	110	4.4	35.8	13.9	0.2	0.4
393.6	120	4.3	35.8	13.8	0.2	0.3
426.4	130	4.3	35.7	13.7	0.2	0.3
459.2	140	4.3	35.7	13.6	0.2	0.3
492.0	150	4.3	35.6	12.6	0.2	0.3
524.8	160	4.3	35.4	10.7	0.2	0.3
557.6	170	**4.2**	35.2	9.5	0.2	0.3
590.4	180	**4.2**	35.1	8.7	0.2	**0.2**
623.2	190	**4.2**	**35.0**	**8.4**	0.2	**0.2**
Ascent						
590.4	180	**4.2**	35.1	8.7	0.2	**0.2**
557.6	170	**4.2**	35.2	9.4	0.2	**0.2**
524.8	160	**4.2**	35.3	10.5	0.2	**0.2**
492.0	150	4.3	35.5	12.2	0.2	**0.2**
459.2	140	4.3	35.7	13.4	0.2	**0.2**
426.4	130	4.3	35.7	13.7	0.2	**0.2**
393.6	120	4.3	35.8	13.8	0.2	**0.2**
360.8	110	4.3	35.8	13.8	0.2	**0.2**
328.0	100	4.4	35.8	14.1	0.2	**0.2**
295.2	90	4.8	35.9	15.2	0.2	**0.2**
262.4	80	5.4	36.0	17.0	0.2	0.3
229.6	70	6.2	36.1	19.4	0.3	0.7
196.8	60	6.8	36.2	21.8	0.3	2.2
164.0	50	***7.1***	***36.3***	24.9	0.2	5.6
131.2	40	6.9	***36.3***	26.1	**0.1**	9.0
98.4	30	6.8	36.2	26.5	**0.1**	14.0
65.6	20	6.7	36.2	***26.7***	**0.1**	19.6
32.8	10	6.7	36.2	***26.7***	**0.1**	26.7
0.0	0	6.7	36.2	***26.7***	0.2	41.9

*****Bin averaging was set at 32.8 feet (10 meters). See Table 5 for 16.4-foot (5-meter) bin averaging results.
Numbers in bold represent the minimum value for a given parameter at Station PE11-6.
Numbers in bold and italics represent the maximum value for a given parameter at Station PE11-6.

CTD-Profile Parameters taken May 2011 from Station PE11-7*						
Depth		**Range of Parameters**				
Feet	**Meters**	**Dissolved Oxygen (mg/L)**	**Salinity (ppt)**	**Temperature (°C)**	**Turbidity (FTU)**	**Normalized PAR (%)**
Descent						
0.0	0	6.6	36.2	***26.7***	***1.3***	***95.5***
32.8	10	6.7	36.2	***26.7***	**0.1**	23.2
65.6	20	6.7	36.2	***26.7***	**0.1**	19.6
98.4	30	6.8	36.2	26.5	0.2	14.6
131.2	40	6.9	36.3	25.9	0.2	9.5
164.0	50	***7.2***	***36.4***	24.6	0.2	5.8
196.8	60	7.1	36.3	22.2	0.3	2.8
229.6	70	6.5	36.3	19.7	0.2	1.1
262.4	80	5.8	36.1	17.5	0.2	0.7
295.2	90	5.1	35.9	15.6	0.3	0.6
328.0	100	4.7	35.8	14.4	0.2	0.5
360.8	110	4.4	35.8	14.0	0.2	0.5
393.6	120	4.3	35.8	13.8	0.2	0.4
426.4	130	4.3	35.7	13.7	0.2	0.4
459.2	140	4.3	35.7	13.5	0.2	0.4
492.0	150	4.4	35.6	12.5	0.2	0.4
524.8	160	4.4	35.5	11.3	**0.1**	0.4
557.6	170	4.3	35.3	10.0	**0.1**	0.4
590.4	180	**4.2**	35.2	9.3	**0.1**	0.4
623.2	190	**4.2**	35.1	9.1	**0.1**	0.4
656.0	200	**4.2**	35.1	8.7	**0.1**	**0.3**
688.8	210	**4.2**	**35.0**	8.4	0.2	**0.3**
721.6	220	**4.2**	**35.0**	**8.1**	0.1	**0.3**
Ascent						
688.8	210	**4.2**	**35.0**	8.4	0.2	**0.3**
656.0	200	**4.2**	35.1	8.7	**0.1**	**0.3**
623.2	190	**4.2**	35.1	9.1	**0.1**	**0.3**
590.4	180	**4.2**	35.2	9.3	**0.1**	**0.3**
557.6	170	4.3	35.2	9.9	**0.1**	**0.3**
524.8	160	4.3	35.4	11.2	**0.1**	**0.3**
492.0	150	4.3	35.6	12.3	**0.1**	**0.3**
459.2	140	4.3	35.7	13.4	0.2	**0.3**
426.4	130	4.3	35.7	13.7	0.2	**0.3**
393.6	120	4.3	35.8	13.8	0.2	**0.3**
360.8	110	4.3	35.8	14.0	0.2	**0.3**
328	100	4.5	35.8	14.5	0.2	**0.3**
295.2	90	5.1	35.9	15.8	0.2	0.4
262.4	80	5.6	36.2	18.0	0.2	0.5
266.0	70	6.3	36.3	19.8	0.2	1.0
196.8	60	7.0	36.3	22.3	0.2	2.7
164.0	50	***7.2***	36.3	24.5	0.2	5.5
131.2	40	6.9	36.3	26.0	**0.1**	9.4
98.4	30	6.8	36.2	26.5	**0.1**	15.0
65.6	20	6.7	36.2	***26.7***	**0.1**	23.1
32.8	10	6.7	36.2	***26.7***	**0.1**	35.9
0.0	0	6.7	36.2	***26.7***	0.2	94.4

*****Bin averaging was set at 32.8 feet (10 meters). See Table 6 for 16.4 foot (5 meter) bin averaging results.

Numbers in bold represent the minimum value for a given parameter at Station PE11-7.
Numbers in bold and italics represent the maximum value for a given parameter at Station PE11-7.

Water physical samples were collected by Niskin bottle from Station PE11-6 on May 5, 2011, during ebb tide. Samples were taken near the water's surface (16 feet below surface), at 213 feet below the surface, at 410 feet below the surface, and near-bottom at 623 feet below the surface.

Total suspended solids was the only parameter tested in water samples, and ranged from a low of 6.0 mg/L in 213 feet of water within a thermocline to a high of 13.0 mg/L in 410 feet of water within an isotherm. All sample concentrations exceeded both the MDL and the MRL. Below is a summary of results per sampled depth.

Total Suspended Solids in Water Column at Station PE11-6 in May 2011*			
Position within Water Column	**Depth of Sample (ft)**	**Depth of Sample (m)**	**Total Suspended Solids (mg/L)**
Near surface	16.4	5.0	8.5
Near surface (field split)	16.4	5.0	7.5
Within thermocline	213.2	65.0	6.0
Within lower isotherm	410.0	125.0	13.0
Near bottom	623.2	190.0	7.0

***See Table 7 for additional data.

4.3 Sediment Physical Results (Appendix F, Table 8, Figure 3)

Sediment samples were collected on May 3, 2011, from water depths ranging from 604.2 to 706.8 feet at Stations PE11-1 through PE11-5. Station PE11-1 is within the existing ODMDS and sediment results may have been affected by disposal activities. All samples were taken within the upper 13 cm of sediment using a van Veen grab sampler, and the results discussed refer to this surficial layer. In the results and discussion below, station names (e.g., Station PE11-1) are used in place of the longer sample ID (e.g., PE11-1-SED) to more easily show spatial relationships between samples. See Map 1 for spatial relationships of the sediment-sampled stations. In each case a station number represents a single sediment sample (or two, in the case of the field split sample) from that locale. Physical properties of the Station PE11-1 sample is averaged with the field split sample in the discussion below. Table 8 presents results of grain-size analyses, percent total solids, soil classifications, percent passing sieve sizes, and hydrometer results. Appendix F includes a full laboratory report of sediment physical analyses along with field photographs of sediment samples. Figure 3 compares grain-size results between stations. The following table summarizes sediment grain sizes per station.

Summary of Sediment Grain Size Analysis Results[1]				
Station Number[3]	Spatial Relationship to Expansion Areas	Sediment Composition[2]		
		% Gravel	% Sand	% Silt & Clay
PE11-1	Inside Existing ODMDS	0.0	64.3	35.7
PE11-2	Inside Expansion Areas	0.0	64.9	35.1
PE11-3		0.0	55.7	44.3
PE11-4	Outside Expansion Areas	0.0	58.3	41.7
PE11-5		0.0	63.6	36.4

[1]See Table 8 for a complete summary of grain sizes and other physical characteristics.
[2]Particle sizes: gravel ≥4.750 mm, sand = 0.075–4.749 mm, silt & clay <0.075 mm.
[3]Station PE11-1 results were averaged with the field split sample.

Samples contained mostly sand (55.7% to 64.9% by weight). Of the three main sand grain-size categories (coarse, medium, fine) among sampled stations, fine sand amounted to the highest percentage (49.5% to 54.3%), followed by medium sand. All samples contained greater than 35.0% silt and clay combined and ranged from 35.1% to 44.3% with the highest percentage found at Station PE11-3 (within the expansion areas). Samples contained more silt (23.3% to 28.9%) than clay (12.1% to 15.4%). Gravel was not present in any sediment sample. Percent total solids ranged little (70.7% and 74.1%) among samples, with the sample from Station PE11-5 (south of the expansion areas) having the greatest percentage.

Based on physical analysis results, the samples from within the expansion areas and ODMDS have analogous physical characteristics as those taken from outside these areas. The following summary table compares grain size ranges between sites. Table 8 offers a complete summary of grain size and other physical parameters.

Summary of Sediment Grain Size Analysis in Relation to the Expansion Areas[1]				
Location of Pooled Samples[2]	% Gravel[3] (Range)	% Sand[3] (Range)	% Silt & Clay[3] (Range)	USCS[4] Classification(s)
Inside Existing ODMDS	0.0	64.3	35.7	SC-SM
Inside Expansion Areas	0.0–0.0	55.7–64.9	35.1–44.3	SC-SM (all samples)
Outside Expansion Areas	0.0–0.0	58.3–63.6	36.4–41.7	SC-SM (all samples)

[1]See Table 8 for a complete summary of grain size and other physical parameters.
[2]Results of the ODMDS sample (Station PE11-1) were averaged with the field split sample.
[3]Particle sizes: gravel ≥4.750 mm, sand = 0.075–4.749 mm, silt and clay <0.075 mm.
[4]Unified Soil Classification System codes are: SC = clayey sand, SM = silty sand

4.4 Sediment Chemical Results (Tables 9–12, Appendix G)

Analytical results for sediment samples collected from May 3, 2011, from water depths ranging from 604.2 to 706.8 feet, are presented in Tables 9 through 12. The term *'J-qualified'* is used here to refer to estimated concentrations that are higher than, or the same concentration as,

the MDL but less than the MRL for the analyte in question. Such J-qualified concentrations in sediment are flagged with a 'J' qualifier in Tables 9 through 12. The full laboratory report of sediment chemistry results is in Appendix G. The following sections compare sample results between stations and between groups of stations (representing conditions inside and outside the expansion areas).

4.4.1 Metals, Total Organic Carbon, and Organotins (Table 9)

All tested metals except silver and mercury were detected in concentrations greater than the MRL in all of the samples. Silver was detected in concentrations greater than the MDL but less than or equal to the MRL in most of the samples (J-qualified), and exceeded the MRL in one sample. Mercury was found in J-qualified concentrations in two samples. Percent total organic carbon was detected above the MRL in all samples. All three organotin cations were detected in a sample and field split from Station PE11-1 (inside the ODMDS) in concentrations from 3.1 to 24 µg/kg. Samples from Stations PE11-2 and PE11-5 had detected concentrations of one organotin cation each at levels greater than the MDL but less than the MRL (J-qualified). The remaining two samples had no detectable levels of organotins. The Station PE11-1 sample together with the field split sample had the maximum detected concentrations of 50% of the 10 metals tested along with all three butyltin cations and total organotins (as tin). All results were below the TEL, ERL, and AET values for the analytes tested. These results compare well with results of samples collected in October 2007 north of the ODMDS, which did not exceed these thresholds for metals, organotins, or TOC (ANAMAR 2010). Analytical results for metals in samples collected in 1998 from within, north, and south of what is now the existing ODMDS (then, the 4-mile candidate site) had similar cadmium (<0.1 to 0.15 mg/kg), lower copper (2.2 to 2.5 mg/kg), higher lead (26 to 28 mg/kg), and similar mercury (<0.05 mg/kg) concentrations compared to the present study (EPA 1999). The following table summarizes the range of concentrations of metals, total organic carbon, and organotins for all stations.

Summary of the Range of Values for Dry Weight Metal, Total Organic Carbon, and Organotin Results[1]	
Analyte	**Range of Values[2] (mg/kg)**
Arsenic	1.62–2.41
Cadmium	0.062–0.092
Chromium	10.7–13.2
Copper	2.24–8.23
Lead	1.520–5.660
Mercury	0.014–0.026
Nickel	8.30–13.6
Selenium	0.13–0.25
Silver	0.007–0.017
Zinc	3.8–6.8
	(%)
Carbon, Total Organic	0.309–0.868
	(µg/kg)
Tri-n-butyltin Cation	<0.61–24
Di-n-butyltin Cation	<0.27–3.3
N-butyltin Cation	<0.38–3.1
Total Organotins (as Sn)	0.65–13

[1]See Table 9 for a complete summary of analytical results for metals, total organic carbon, and organotins.
[2]Includes all sampled stations from inside and outside of the expansion areas.
'<' Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).

When sample results were compared between stations, there was little difference in metal or total organic carbon concentrations between stations inside and outside of the expansion areas based on these results. The existing ODMDS held the maximum detected concentration of all organotin cations and total organotins (as tin). The existing ODMDS also held maximum detected levels of 50% of the 10 metals tested along with total organic carbon. The expansion areas held maximum detected levels of 40% of the 10 metals tested. The maximum detected concentration of chromium (13.2 mg/kg) came from outside the expansion areas. No sample exceeded the TEL, ERL, or AET values for any analyte. The following table summarizes the range of concentrations of metals, total organic carbon, and organotins in relation to the expansion areas.

Summary of Dry Weight Metal, Total Organic Carbon, and Organotin Results in Relation to the Expansion Areas[1]			
	Range of Values		
Analyte	Inside Existing ODMDS[2] (mg/kg)	Inside Expansion Areas (mg/kg)	Outside Expansion Areas (mg/kg)
Arsenic	1.95–2.12	1.62–2.41	1.66–2.34
Cadmium	0.062–0.063	0.075–0.092	0.082–0.088
Chromium	10.7–11.1	10.7–12.4	10.7–13.2
Copper	4.38–8.23	2.24–2.70	2.38–2.69
Lead	3.490–5.660	1.720–2.080	1.520–2.130
Mercury	0.022–0.026	0.014–0.020	0.015–0.022
Nickel	8.30–9.45	10.1–13.6	12.1–13.1
Selenium	0.13–0.15	0.17–0.25	0.22–0.23
Silver	0.015–0.017	0.012–0.012	0.007–0.012
Zinc	6.5–6.8	3.9–4.3	3.8–4.3
	(%)	**(%)**	**(%)**
Carbon, Total Organic	0.387–0.680	0.309–0.868	0.238–0.769
	(µg/kg)	**(µg/kg)**	**(µg/kg)**
Tri-n-butyltin Cation	18–24	<0.64–0.81	<0.61–<0.63
Di-n-butyltin Cation	2.7–3.3	<0.28–<0.29	<0.27–<0.28
N-butyltin Cation	2.5–3.1	<0.39–<0.39	<0.37–0.39
Total Organotins (as Sn)	11–13	0.67–0.74	0.65–0.66

[1]See Table 9 for a complete summary of analytical results for metals, total organic carbon, and organotin.
[2]Sediment results from the existing ODMDS consist of a sample and field split from Station PE11-1.
"<" Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).

4.4.2 Organochlorine Pesticides (Table 10)

No organochlorine pesticides were detected in any sample from stations outside the ODMDS. This compares well with results of samples collected in October 2007 north of the ODMDS and results of samples taken in 1998 from within, north, and south of the ODMDS, all of which resulted in non-detects for the pesticides tested (EPA 1999, ANAMAR 2010). The sample and field split from Station PE11-1 (inside the existing ODMDS) contained detected levels of four organochlorine pesticides in concentrations greater than the MDL, of which p,p' (4,4')-DDD was the only pesticide detected in concentrations above the MRL. The Station PE11-1 sample had a concentration of 160 µg/kg of p,p' (4,4')-DDD, which greatly exceeded the TEL, ERL, and AET. This result appears to be an anomaly considering that p,p' (4,4')-DDD was not detected in the field split sample taken from Station PE11-1. The difference in p,p' (4,4')-DDD concentrations between the PE11-1 sample and its field split may be attributable to heterogeneity of the sample and matrix interferences as indicated by results of laboratory screening (See Section 5.2.2 for the QA/QC review of pesticide results of this sample). All other sample results were

well below the TEL, ERL, and AET values for the organochlorine pesticides tested. The summary below provides the range of detected pesticide concentrations among stations.

Summary of the Range of Values for Dry Weight Organochlorine Pesticide Results, Excluding Non-Detected Analytes[1]	
Analyte	**Range of Values (µg/kg)**
Chlordane & Derivatives:	
γ (trans)-Chlordane	<0.090–0.10
DDT & Derivatives:	
p,p' (4,4')-DDD	<0.11–**160**
p,p' (4,4')-DDE	<0.11–0.27
o,p' (2,4')-DDT	<0.17–0.45

[1]See Table 10 for a complete summary of pesticide analysis results.
"<" Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).
Numbers in bold denote a value greater than or equal to the TEL, ERL, and AET. See Section 5.2.2 for a QA/QC discussion of results for this sample (PE11-1-SED).

When comparing results in relation to the proposed expansion areas and the existing ODMDS, detected amounts of the analytes were only found inside the ODMDS. The concentrations detected inside the ODMDS were lower than the MRL except in the case of p,p' (4,4')-DDD, which exceeded the MRL as well as the TEL, ERL, and AET. All sediment pesticide analyte levels were non-detects inside and outside the expansion areas. The summary below provides the range of detected pesticide concentrations in relation to the expansion areas.

Summary of Dry Weight Organochlorine Pesticide Results in Relation to the Expansion Areas, Excluding Non-Detected Analytes[1]			
	Range of Values		
Analyte	**Inside ODMDS (µg/kg)**	**Inside Expansion Areas (µg/kg)**	**Outside Expansion Areas (µg/kg)**
Chlordane & Derivatives:			
γ (trans)-Chlordane	<0.090–0.10	<0.090–<0.090	<0.090–<0.090
DDT & Derivatives:			
p,p' (4,4')-DDD	<0.33–**160**	<0.11–<0.11	<0.11–<0.11
p,p' (4,4')-DDE	<0.74–0.27	<0.11–<0.11	<0.13–<0.66
o,p' (2,4')-DDT	0.31–0.45	<0.17–<0.17	<0.17–<0.17

[1]See Table 10 for a complete summary of pesticide analysis results.
"<" Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).
Numbers in bold denote a value greater than or equal to the TEL, ERL, and/or AET. See Section 5.2.2 for a QA/QC discussion of results this sample (PE11-1-SED).

4.4.3 Polynuclear Aromatic Hydrocarbons (Table 11)

The Station PE11-1 sample (inside the existing ODMDS) and the field split from this station had results which exceeded the MRL in 78% of the 18 PAH analytes tested, and held the maximum detected concentration in the same 14 PAHs. Furthermore, the Station PE11-1 sample results exceeded the TEL for acenaphthene, dibenzo(a,h)anthracene, fluoranthene, and phenanthrene with concentrations of 8.8, 6.5, 120, and 100 µg/kg, respectively. No other sample had detected concentrations above the MRL. The remaining four samples each had between four and five analytes detected, but these results were J-qualified. Benzo(a)anthracene, benzo(b)fluoranthene, fluoranthene, and pyrene were detected in sediment from all six sampled stations. With the exception of the PE11-1 sample, all other sample results were below the TEL, ERL, and AET values for the PAHs tested. No sample result exceeded the TEL, ERL, or AET for total LMW PAHs, total HMW PAHs, or total PAHs. With the exception of Sample PE11-1, the results of the present study are similar to those of samples collected in October 2007 north of the ODMDS, where no PAH or calculated PAH results exceeded these thresholds (ANAMAR 2010). Results of samples collected in 1998 within, north, and south of what is now the ODMDS (then, the 4-mile candidate site) were tested for total petroleum hydrocarbons, which were all below detection limits (EPA 1999). A summary of PAH results is given below.

Summary of the Range of Values for Dry Weight PAH Results, Excluding Non-Detected Analytes[1]	
Analyte	**Range of Values (µg/kg)**
1-Methylnaphthalene	<0.51–1.1
2-Methylnaphthalene	<0.46–1.5
Acenaphthene	<0.76–**8.8**
Acenaphthylene	<0.59–1.7
Anthracene	<0.58–20
Benzo(a)anthracene	0.76–51
Benzo(a)pyrene	<0.76–44
Benzo(b)fluoranthene	1.1–72
Benzo(g,h,i)perylene	<0.85–34
Benzo(k)fluoranthene	<0.87–25
Chrysene	<0.80–54
Dibenzo(a,h)anthracene	<0.80–**6.5**
Fluoranthene	1.2–**120**
Fluorene	<0.61–11
Indeno(1,2,3-cd)pyrene	<0.87–34
Naphthalene	<0.60–2.4
Phenanthrene	<1.4–**100**
Pyrene	1.2–91
Total LMW[2] PAHs	4.9–145
Total HMW[2] PAHs	5.5–367
Total PAHs	14.9–677

[1]See Table 11 for a complete summary of sediment PAH analysis results.
[2]LMW = low molecular weight; HMW = high molecular weight. See Table 11 for calculations.
"<" Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).
Numbers in bold denote a value greater than or equal to the TEL, ERL, and/or AET. See Section 5.2.5 for a QA/QC discussion of results of this sample (PE11-1-SED).

The existing ODMDS had maximum detected concentrations of all 18 PAH analytes tested plus total LMW PAHs, total HMW PAHs, and total PAHs. The ODMDS also exceeded the TEL for acenaphthene, dibenzo(a,h)anthracene, fluoranthene, and phenanthrene in one sample. Five PAH analytes were detected inside the expansion areas, and the same number was detected outside these areas. Analytes detected inside and outside the expansion areas were present only in concentrations below the MRL (J-qualified). Sediment PAH concentrations inside the expansion areas are similar to those found outside these areas based on these results. The following table summarizes the range of detected PAH concentrations in relation to the expansion areas.

Summary of Dry Weight PAH Results in Relation to the Expansion Areas, Excluding Non-Detected PCB Congeners[1]			
	Range of Values		
Analyte	Inside Existing ODMDS (µg/kg)	Inside Expansion Areas (µg/kg)	Outside Expansion Areas (µg/kg)
1-Methylnaphthalene	<0.51–1.1	<0.51–<0.51	<0.51–<0.51
2-Methylnaphthalene	0.66–1.5	<0.46–<0.46	<0.46–<0.46
Acenaphthene	<0.76–**8.8**	<0.76–<0.76	<0.76–<0.76
Acenaphthylene	0.63–1.7	<0.59–<0.59	<0.59–<0.59
Anthracene	2.5–20	<0.58–<0.58	<0.58–<0.58
Benzo(a)anthracene	20–51	0.78–1.1	0.76–0.89
Benzo(a)pyrene	20–44	<0.76–<0.76	<0.76–<0.76
Benzo(b)fluoranthene	37–72	1.3–1.4	1.1–1.3
Benzo(g,h,i)perylene	12–34	<0.85–0.87	<0.85–<0.85
Benzo(k)fluoranthene	13–25	<0.87–<0.87	<0.87–<0.87
Chrysene	19–54	<0.80–<0.80	0.92–1.3
Dibenzo(a,h)anthracene	2.4–**6.5**	<0.80–<0.80	<0.80–<0.80
Fluoranthene	23–**120**	1.2–1.2	1.3–1.3
Fluorene	0.84–11	<0.61–<0.61	<0.61–<0.61
Indeno(1,2,3-cd)pyrene	12–34	<0.87–<0.87	<0.87–<0.87
Naphthalene	0.74–2.4	<0.60–<0.60	<0.60–<0.60
Phenanthrene	7.2–**100**	<1.4–<1.4	<1.4–<1.4
Pyrene	25–91	1.2–1.4	1.2–1.3
Total LMW[2] PAHs	13.2–145	4.9–4.9	4.9–4.9
Total HMW[2] PAHs	109–367	5.5–6.1	6.0–6.1
Total PAHs	198–677	14.9–15.6	15.3–15.4

[1]See Table 11 for a complete summary of PAH analysis results.
[2]LMW = low molecular weight; HMW = high molecular weight. See Table 11 for calculations.
"<" Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).
Numbers in bold denote a value greater than or equal to the TEL, ERL, and/or AET. See Section 5.2.5 for a QA/QC discussion of results of this sample (PE11-1-SED).

4.4.4 Polychlorinated Biphenyls (Table 12)

PCB congeners discussed in this report refer to standard numerical descriptors in place of the full chemical name. For example, PCB 8 is used in place of the name 2,4'-dichlorobiphenyl.

The Station PE11-1 (inside the existing ODMDS) sample and the field split from this station collectively contained detected levels of 14 PCB congeners. However, none of the detected levels from this station exceeded the MRL (J-qualified). No other station had detected levels of any of the PCB congeners tested. The sample and field split from Station PE11-1 had the maximum detected concentrations of both total EPA Region 4 PCBs and total NOAA PCBs. All

sample results were below the TEL, ERL, and AET for the PCB congeners tested. By comparison, results of samples collected in October 2007 north of the ODMDS showed only one congener detected (PCB 183, detected at an estimated 0.30 µg/kg) (ANAMAR 2010). The analysis of samples collected in 1998 from within, north, and south of what is now the ODMDS (then, the 4-mile candidate site) resulted in PCB levels below detection limits (EPA 1999). The following table presents the range of detected PCB congener concentrations among sampled stations.

Summary of the Range of Values for Dry Weight PCB Results, Excluding Non-Detected PCB Congeners[1]	
PCB Congener	**Range of Values (µg/kg)**
PCB 28	<0.064–0.079
PCB 44	<0.065–0.080
PCB 49	<0.058–0.13
PCB 52	<0.059–0.17
PCB 66	<0.035–0.13
PCB 101	<0.049–0.30
PCB 105	<0.033–0.046
PCB 118	<0.031–0.22
PCB 128	<0.031–0.060
PCB 138	<0.064–0.26
PCB 153	<0.038–0.14
PCB 170	<0.026–0.070
PCB 180	<0.095–0.15
PCB 187	<0.047–0.10
Total EPA Reg. 4 PCBs[2]	(1.45)–(3.34)
Total NOAA PCBs[2]	(2.09)–(4.90)

[1]See Table 12 for a complete summary of PCB analysis results.
[2]See SERIM Section 7.3 for details on Total EPA Region 4 PCBs and Total NOAA PCBs.
"<" Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).
Numbers in parentheses denote a product which included analyte concentrations not detected at or above the MDL (see Table 12 for details).

The existing ODMDS had detected levels of 14 (53.8%) of the 26 PCB congeners, all of which had lower concentrations than the MRL (J-selected). The ODMDS also had the maximum detected concentrations of both total EPA Region 4 PCBs and total NOAA PCBs. In contrast, the expansion areas and surrounding area had no detectable levels of any PCB congener. No analyte concentration exceeded the TEL, ERL, or AET in any sample. The following table presents the range of detected PCB congener concentrations in relation to the expansion areas.

Summary of Dry Weight PCB Results in Relation to the Expansion Areas, Excluding Non-Detected PCB Congeners[1]			
PCB Congener Number	Range of Values		
	Inside Existing ODMDS (µg/kg)	Inside Expansion Areas (µg/kg)	Outside Expansion Areas (µg/kg)
PCB 28	<0.093–0.079	<0.064–<0.064	<0.064–<0.064
PCB 44	0.077–0.080	<0.065–<0.065	<0.065–<0.065
PCB 49	<0.25–0.13	<0.058–<0.058	<0.058–<0.058
PCB 52	<0.29–0.17	<0.059–<0.059	<0.059–<0.059
PCB 66	<0.19–0.13	<0.035–<0.035	<0.035–<0.035
PCB 101	<0.37–0.30	<0.049–<0.049	<0.049–<0.049
PCB 105	0.037–0.046	<0.033–<0.033	<0.033–<0.033
PCB 118	0.11–0.22	<0.031–<0.031	<0.031–<0.031
PCB 128	<0.045–0.060	<0.031–<0.031	<0.031–<0.031
PCB 138	0.19–0.26	<0.064–<0.064	<0.064–<0.064
PCB 153	<0.038–0.14	<0.038–<0.038	<0.038–<0.038
PCB 170	0.036–0.070	<0.026–<0.026	<0.026–<0.026
PCB 180	<0.095–0.15	<0.095–<0.095	<0.095–<0.095
PCB 187	<0.047–0.10	<0.047–<0.047	<0.047–<0.047
Total EPA Reg. 4 PCBs[2]	(2.94)–(3.34)	(1.45)–(1.74)	(1.45)–(1.45)
Total NOAA PCBs[2]	(4.35)–(4.90)	(2.09)–(2.09)	(2.09)–(2.09)

[1]See Table 12 for a complete summary of PCB analysis results.
[2]See SERIM Section 7.3 for details on Total EPA Region 4 PCBs and Total NOAA PCBs.
"<" Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).
Numbers in parentheses denote a product which included analyte concentrations not detected at or above the MDL (see Table 12 for details).

4.5 Benthic Infaunal Results (Appendix D)

Infaunal sampling was conducted on May 3, 2011, between 11:00 and 17:30. Three replicate samples were taken from each of five stations, for a total of 15 samples. Due to the mean penetration depth of 7.1 cm (range = 6.3 to 8.0 cm), analyses here address mostly surficial infaunal communities. However, considering that infaunal organisms found within the upper 4 cm and their associated biomass dominate over those found in lower strata (Lie and Pamatmat 1965), the results give an acceptably accurate representation of the infaunal community. Water depths ranged from 603.6 to 707.2 feet. Conditions during infaunal sampling consisted of 5- to 15-knot (2 to 4 on the Beaufort scale) easterly winds, 1- to 2-foot seas, and clear to partly cloudy skies. During infaunal sampling, tides consisted of ebb, slack, and flood (during a new moon phase).

Mean sediment grain size for infaunal samples consisted of mainly very fine sand (73.3% of replicate samples) with the remainder being fine sand (20.0%) and silt/clay with very fine sand (6.7%) based on field notes. Live worms were observed in 46.6% of the samples during

sieving. Shell fragments, broken glass, and clay balls were sometimes observed in samples while sieving. Field observations during infaunal sampling are summarized in Table 3.

Infaunal samples shared all five stations with sediment sampling. Sampling effort inside and outside of the expansion areas is summarized below. The following results were summarized from data presented in Barry Vittor & Associates (2011), which can be found in Appendix D.

Infaunal Sampling Effort in Relation to the Expansion Areas	
Location	**Seafloor Sampled[1] m^2 (number of replicate samples)**
Inside Existing ODMDS	0.12 (3 samples)
Inside Expansion Areas	0.24 (6 samples)
Outside Expansion Areas	0.24 (6 samples)

[1]Three replicate samples per station; each replicate sample covered 0.04 m^2 of surface area.

4.5.1 Wet Weight Biomass

Total infaunal biomass results were averaged between replicate samples to obtain the mean per station. Mean total infaunal wet weight biomass per station ranged from 0.0575 grams at Station PE11-4 to 0.2287 grams at Station PE11-2. The two highest biomass stations (PE11-1 and PE11-2) are located inside the expansion areas and inside the ODMDS. Annelid worms represented the largest percentage of biomass (50.0% to 90.8% of a station's mean biomass) of all invertebrate groups (Barry Vittor & Associates 2011).

Mean Infaunal Total Wet Weight Biomass per Station[1], Listed by Rank		
Station Number	**Relationship to Expansion Areas**	**Total Mean Wet Weight Biomass (grams)**
PE11-2	Inside Expansion Areas	0.2287
PE11-1	Inside Existing ODMDS	0.2285
PE11-3	Inside Expansion Areas	0.1882
PE11-5	Outside Expansion Areas	0.1673
PE11-4	Outside Expansion Areas	0.0575

[1]Source: Barry Vittor & Associates (2011).

Mean total wet weight infaunal biomass was greatest inside the ODMDS (0.2285 grams). Mean total biomass inside the expansion areas (0.2084 grams) was significantly greater than outside the expansion areas (0.1124 grams). Mean total infaunal biomass is tabulated below in relation to the expansion areas.

Total Wet Weight Biomass in Relation to the Expansion Areas[1], Listed by Rank	
Area of Interest	**Mean of Samples: Total Wet Weight Biomass (grams)**
Inside Existing ODMDS	0.2285
Inside Expansion Areas	0.2084
Outside Expansion Areas	0.1124

[1]Source: Barry Vittor & Associates (2011).

4.5.2 Taxonomic Richness and Diversity

A total of 1,053 individual infaunal organisms representing 141 taxa were identified from the May 2011 survey samples.

The two stations inside the expansion areas combined with the station in the existing ODMDS accounted for 800 infaunal organisms representing 122 taxa. Of the major groups found inside the expansion areas and ODMDS, polychaete worms were most abundant (66.1% of the 800 individuals), followed by oligochaete worms (9.4%) and bivalve mollusks (5.5%). Polychaete worms were also the most diverse of these groups, accounting for 67.9% of all taxa, followed by malacostracan crustaceans (10.3%) and bivalves (9.0%) (Barry Vittor & Associates 2011).

The two stations outside the expansion areas accounted for 253 individuals representing 78 taxa. Of the major groups found inside the expansion areas, polychaete worms were again most abundant (73.5% of the 253 individuals), followed by oligochaete worms (7.5%) and bivalve mollusks (8.4%). Polychaete worms were also the most diverse of these groups, accounting for 63.1% of all taxa, followed by bivalves (12.3%) and malacostracan crustaceans (10.7%) (Barry Vittor & Associates 2011).

Station PE11-1 (inside the existing ODMDS) had a total of 83 infaunal taxa and represented the highest taxa richness among stations. Station PE11-4 had the lowest taxa richness among stations, with 30 taxa. Station PE11-1 had the greatest mean density among stations, at 3,266.7 individuals per square meter. Station PE11-4 had the least density among stations, at 491.4 individuals per square meter. The following summary table provides station mean infaunal density by rank.

Mean Total Infaunal Density per Station[1], Listed by Rank		
Station Number	**Relationship to Expansion Areas**	**Mean Total Infaunal Density (individuals/m^2)**
PE11-1	Inside Existing ODMDS	3,266.7
PE11-2	Inside Expansion Areas	2,766.7
PE11-5	Outside Expansion Areas	1,616.7
PE11-3	Inside Expansion Areas	633.3
PE11-4	Outside Expansion Areas	491.7

[1]Source: Barry Vittor & Associates (2011).

The greatest mean total infaunal density was found inside the ODMDS (3,266.7 individuals per square meter). The expansion areas held a mean total infaunal density of 1,700.0 individuals per square meter, which was somewhat greater than that found outside these areas (1,054.2 individuals per square meter). It should be noted, however, that mean infaunal densities ranged greatly between stations inside the expansion areas and outside these areas. Using an analysis of variance on natural logarithm-transformed density data, Barry Vittor & Associates (2011) found no significant differences in density in relation to the expansion areas. The summary below provides mean infaunal density in relation to the expansion areas.

Mean Total Infaunal Densities in Relation to the Expansion Areas[1]	
Area of Interest	**Mean Total Infaunal Density (individuals/m^2)**
Inside Existing ODMDS	3,266.7
Inside Expansion Areas	1,700.0
Outside Expansion Areas	1,054.2

[1]Source: Barry Vittor & Associates (2011).

The Shannon diversity index is commonly used to measure biological diversity by accounting for numbers of taxa represented in a given sample and evenness of the distribution of individuals across taxa within that sample. The scores derived from this index fit within a range of 0 to 5 (normally 1.5 to 3.5), with scores of less than 1 suggesting relatively polluted and degraded habitat and scores higher than 3 considered indicative of stable and balanced habitat (Türkmen and Kazanci 2010).

All stations had mean Shannon diversity index values that fell either within the normal range of 1.5 to 3.5 (40% of stations) or exceeded this range (60% of stations). Station PE11-1 (inside the ODMDS) held the highest Shannon diversity index value, at 3.89. Station PE11-4 held the lowest index value, at 3.21. Sampled stations show no evidence of habitat degradation based on these values. The following summary presents station infaunal diversity and evenness values.

Mean Infaunal Diversity per Station[1], Listed by Rank				
Station Number	**Relationship to Expansion Areas**	**H' Shannon Diversity Index (log e) Values**	**J' Pielou Evenness Index Values**	**Mean Taxa per Replicate Sample (richness)**
PE11-1	Inside Existing ODMDS	3.89	0.88	47.0
PE11-2	Inside Expansion Areas	3.82	0.88	45.0
PE11-5	Outside Expansion Areas	3.78	0.90	32.7
PE11-3	Inside Expansion Areas	3.23	0.92	15.3
PE11-4	Outside Expansion Areas	3.21	0.94	14.7

[1]Source: Barry Vittor & Associates (2011).

The Pielou evenness index included above was essentially derived from the Shannon index and operates on a scale of 0 to 1 (Pielou 1966). The closer the Pielou index value is to 1, the greater the distribution of individuals among taxa represented in samples (Pielou 1966). As

shown in the above summary, station evenness index values are negatively correlated (r = -0.94) with Shannon diversity index values.

Due to the normalized sample size for infaunal grab samples in this study (exactly three replicate samples per station, each of uniform size), a direct comparison of taxa richness was used between stations in place of the Margalef richness index.

Infaunal index values inside and outside the expansion areas were ascertained from the mean of associated station index values. The existing ODMDS held the greatest Shannon diversity index value (3.89). Mean Shannon diversity index values were similar between the expansion areas (3.53) and outside these areas (3.50). Mean Pielou evenness index values were very similar between the ODMDS, the expansion areas, and outside these areas (range = 0.88 to 0.92). Mean taxa per replicate sample (taxa richness) varied somewhat between the expansion areas (30.2) and outside these areas (23.7), but was greatest inside the ODMDS (47.0). No significant differences were observed between mean taxa richness inside versus outside of the expansion areas. Mean infaunal index values and taxa richness in relation to the expansion areas are presented in the following table.

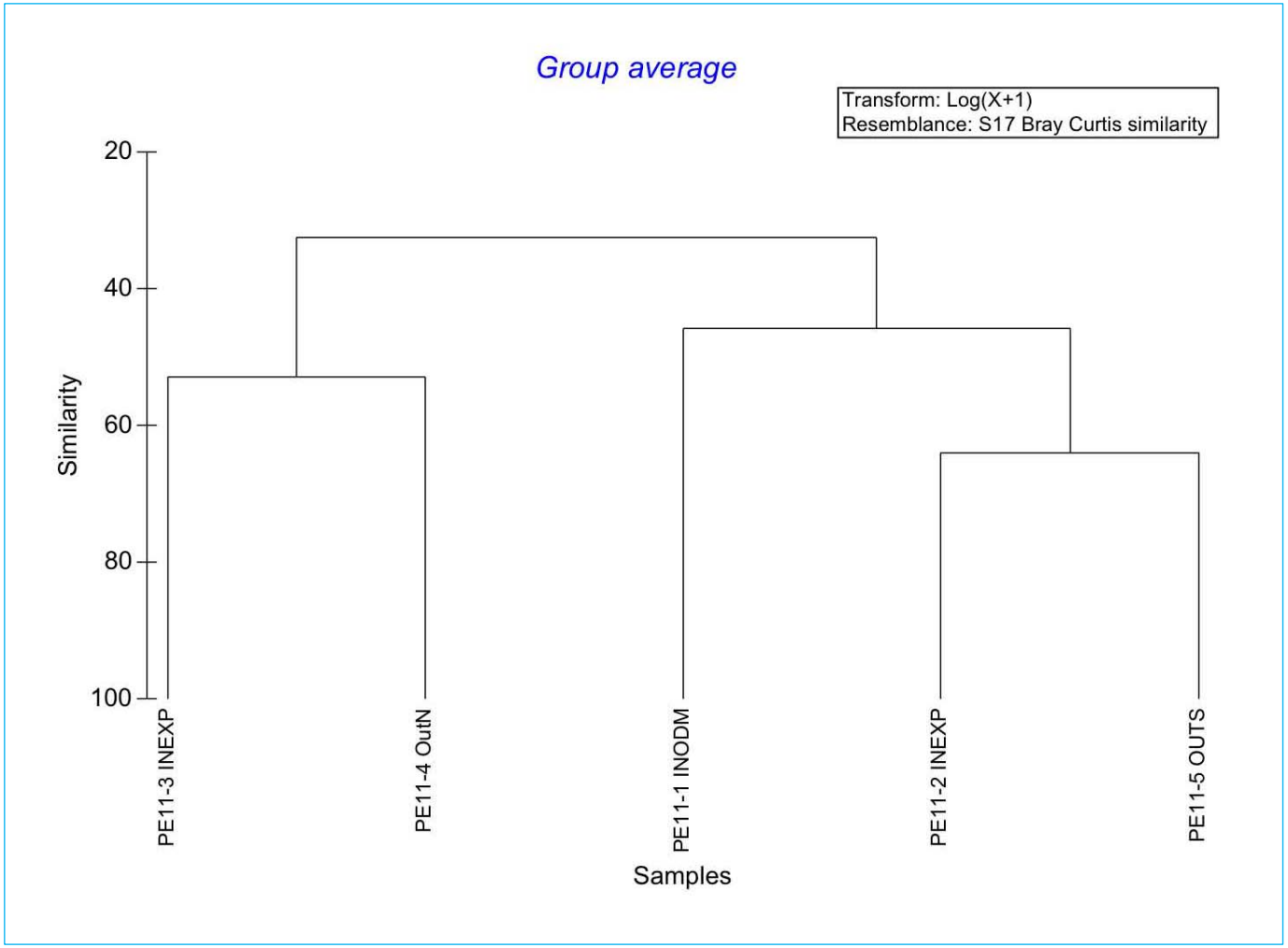
Mean Infaunal Diversity in Relation to the Expansion Areas[1]

Area of Interest	H' Shannon Diversity Index (log e)	J' Pielou Evenness Index	Mean Taxa per Replicate Sample (richness)
Inside Existing ODMDS	3.89	0.88	47.0
Inside Expansion Areas	3.53	0.90	30.2
Outside Expansion Areas	3.50	0.92	23.7

[1]Source: Barry Vittor & Associates (2011).

4.5.3 Cluster and Multidimensional Scaling Analyses

Barry Vittor & Associates (2011) conducted a cluster analysis using the Bray-Curtis similarity coefficient between stations after transformation of the data. Results of the cluster analysis revealed that Stations PE11-3 (inside the expansion areas) and PE11-4 (outside the expansion areas) were most similar to one another. A second cluster was identified consisting of the remaining three stations (PE11-1, PE11-2, and PE11-5), suggesting these three shared similar infaunal parameters, although Station PE11-1 (inside the ODMDS) appeared to be somewhat dissimilar to the other stations based on Barry Vittor & Associates (2011). A non-parametric MDS analysis was then performed on the results of the cluster analysis. Results of the MDS analysis agreed well with those of the cluster analysis.



Cluster analysis of infaunal results from Stations PE11-1 through PE11-5. INEXP = inside expansion areas, INODM = inside existing ODMDS, OUTN = outside and north of existing ODMDS, OUTS = outside and south of existing ODMDS. See Barry Vittor & Associates (2011) for further details.

4.5.4 Community Structure

Based on May 2011 sampling results, the infaunal community is complex and diverse. The following are examples of some of the important taxonomic groups represented. Based on abundance, members of the oligochaete worm family tubificidae are important infaunal community members as they were found at all five stations in significant numbers. Important polychaete worms included *Prionospio* sp., *Levinsenia reducta*, *Cirrophorus* (= *Paradoneis*) *lyra*, and *Spiophanes kroeyeri*. Bivalve mollusks were also important components of infaunal samples and included *Nuculana carpenter* and *Cardiomya costellata*. Ostrocod crustaceans of the family Philomedidae were found at several stations and included the genus *Philomedes*. Gastropods were very few in number but included the family Pyramidellidae. Echinoderms represented low species richness and low abundance at any station and consisted of sea cucumbers of the genus *Leptosynapta* (family Synaptidae). Relatively minor components of the infaunal community included acorn worms of the genus *Balanoglossus* sp., ribbon worms (nemerteans), cnideria (e.g, sea anemones [actiniaria]), one genus of horseshoe worm (phoronids; *Phoronis* sp.), and flatworms (platyhelminthes) of the turbellaria group. A taxonomic list of infaunal invertebrates is included as a Microsoft Excel file in Appendix D.

4.5.5 Comparisons with Results of Previous Surveys

Previous surveys of benthic infauna were conducted in November 1984 (Barry Vittor & Associates 1985) and in May and August 1998 (EPA 1999) within the area offshore of Port Everglades. Samples taken in 1984 from in and around the ODMDS resulted in a mean station density of 4,637 individuals per square meter, which is greater than was found in the present study. Average station total biomass (9.664 grams per square meter) was significantly greater in 1984 samples versus the present study. The 1984 mean Shannon diversity value of 3.62 among the 10 stations sampled, with a mean Pielou evenness value of 0.78 (Barry Vittor & Associates 1985, 2011), which compares well with results of the 2011 survey. Annelid worms dominated in terms of abundance and taxa richness among infaunal groups in 1984 as well as in 2011. A total of 453 taxa were indentified from the samples taken in 1984 (Barry Vittor & Associates 1985), which is significantly greater than the 141 taxa identified in the present study.

Infaunal samples taken in 1998 revealed only 159 taxa identified from stations in and around the (then, candidate site) ODMDS, with a mean station density of 756 individuals per square meter (EPA 1999). 1998 samples were dominated by annelid worms, similar to 1994 and results of the present study. The 1998 samples had a mean Shannon diversity index value of 4.92 at the ODMDS, which is much higher than that of the present study (3.59). The mean Pielou evenness value of 0.79 (EPA 1999) from the 1998 samples are similar to the 0.90 mean evenness value of the present study. However, overall, Barry Vittor & Associates (2011) considered the 1984 and 2011 surveys to be more comparable with one another than the 1998 survey data are to the present study due to the similar relative abundance of annelid worms in 1984 and 2011, at 61.9% and 75.5% of the total assemblege, respectively. This is in contrast to the increased dominance of arthropods during 1998 (Barry Vittor & Associates 2011). Such dominance by annelid worms is considered by Barry Vittor & Associates (2011) to be typical of communities seen in habitats similar to those of the present study.

4.6 Epifaunal Results

Epifaunal trawl samples were collected May 4 and 5, 2011, in water depths of 585.5 to 734.7 feet. Weather conditions consisted of 0- to 15-knot (0 to 4 on the Beaufort scale) easterly

winds, 1- to 4-foot seas, and clear to cloudy skies. Drizzly rain occurred during one trawl tow. Sampling occurred during a spring tide and included most major tidal flux conditions.

Four stations were sampled, with one tow during daylight hours ('day tow') and one after dark ('night tow') conducted per station in order to account for diel changes in epifaunal activity patterns. A trial tow was conducted on May 4 at Station PE11-5 which had poor contact with the seafloor. Four additional tows were conducted on May 5 at Stations PE11-5, PE11-13, and PE11-14 and at an area west of Station PE11-5 to procure additional specimens for tissue sampling. These five trawl tows are omitted from epifaunal analyses. An estimated 37,612 m^2 of seafloor were sampled, not including tissue-only and trial trawl tows. The trawl sampling effort is summarized in the following table.

Epifaunal Trawl Sampling Effort in Relation to the Expansion Areas[1]	
Area of Interest	**Total Effort per Area m^2 (no. of tows)**
Inside Expansion Areas	16,738 (4 tows)
Outside Expansion Areas	20,874 (4 tows)

[1]Trial tows and tows used only for tissue samples are omitted from this summary table.

Based on trawl contents along with gear wear, nearly all tows covered primarily soft substrates having scattered trash (cans, bottles, rope, monofilament fishing line and terminal tackle), cloth and metal debris, rocks (carbonate rock, coal), and small amounts of plant matter (turtle grass blades [*Thalassia testudinum*], fruits of Australian pine [*Casuarina* sp.]). Turtle grass blades were also identified from photographs taken during a March 1986 survey of the ODMDS conducted by Continental Shelf Associates, Inc. (EPA 2004). A trawl sample from Station PE11-7 (just north of the existing ODMDS) included cobble-sized carbonate rocks and several portions of dead coral which appeared to be rose coral (*Manicina* sp.) (J.H. Slapcinsky *pers. comm.*). The worn appearance of the coral suggests it had been dead for some time.

Left: Carbonate rock and fragments of rose coral (*Manacina* sp.) trawled from Station PE11-7

Right: Rock trawled from Station PE11-5 (note live anemones attached to rock). The 15-cm ruler is included for scale.

4.6.1 Wet Weight Biomass (Tables 13–15, Figures 4–6)

Invertebrate biomass was nearly double that of fish biomass in most trawl samples. The highest biomasses of invertebrates (7.00 kg) and fishes (4.55 kg) were found during a night tow at Station PE11-9 (outside of the expansion areas), which was the shallowest station sampled by trawl. The lowest total biomass was found during a night tow at Station PE11-7 (inside the expansion areas), which resulted in no fishes captured and contained only 0.70 kg of invertebrate biomass. The sea star *Coronaster briareus* often dominated trawl samples in terms of biomass and abundance. Biomass of trawl samples are presented in Table 13. Figure 4 provides a visual comparison.

Station biomass data were compared after converting to kg per 1,000 m^2 sampled. Station PE11-9 (outside the expansion areas) had the highest total biomass, at 1.41 kg. Station PE11-8 (outside the expansion areas) had the lowest total biomass, at 0.14 kg. Table 14 compares biomass results per station and Figure 5 presents a visual representation of the results. Wet weight biomass per station is summarized below.

Mean Epifaunal Wet Weight Biomass per Station[1], Listed by Rank				
Station Number	**Relationship to Expansion Areas**	**Invertebrate Biomass (kg/1,000 m^2)**	**Fish Biomass (kg/1,000 m^2)**	**Total Biomass (kg/1,000 m^2)**
PE11-9	Outside Expansion Areas	0.90	0.51	1.41
PE11-6	Inside Expansion Areas	0.39	0.32	0.71
PE11-7	Inside Expansion Areas	0.23	0.01	0.23
PE11-8	Outside Expansion Areas	0.12	0.04	0.15

[1]See Table 14 for additional data and Figure 5 for a visual comparison.

As with station biomass, comparisons in relation to the expansion areas use normalized values (kg per 1,000 m^2). Highest total biomass was found outside the expansion areas (0.76 kg), which held nearly twice the mass per unit area as inside the expansion areas (0.44 kg). Table 15 presents a comparison of epifaunal biomass inside and outside the expansion areas. Figure 6 presents a visual comparison of these data. The following summary table offers a summary of total biomass relative to the expansion areas.

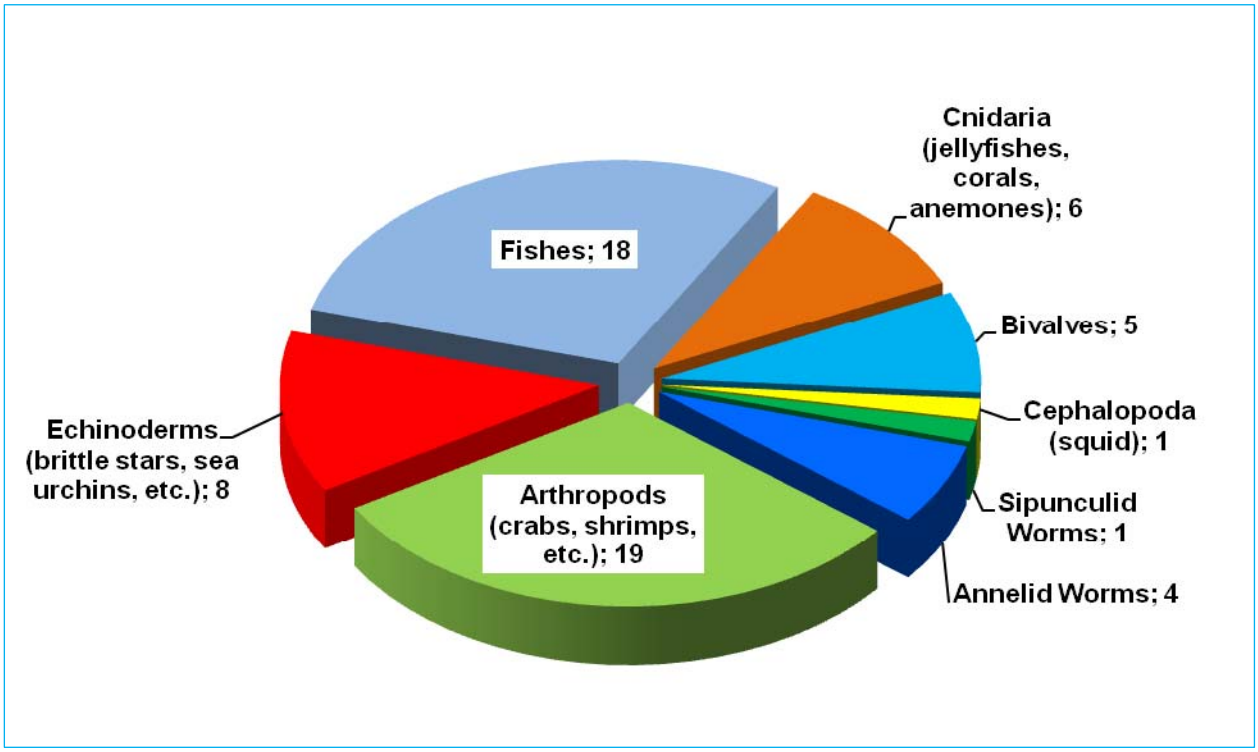
Wet Weight Biomass in Relation to the Expansion Areas, Listed by Rank[1]			
Area of Interest	**Invertebrate Biomass (kg/1,000 m^2)**	**Fish Biomass (kg/1,000 m^2)**	**Total Biomass (kg/1,000 m^2)**
Outside Expansion Areas	0.50	0.27	0.76
Inside Expansion Areas	0.30	0.14	0.44

[1]See Table 15 for further data and Figure 6 for a visual comparison.

4.6.2 Taxonomic Richness and Diversity (Tables 16–22, Figures 7–8, Figure 13)

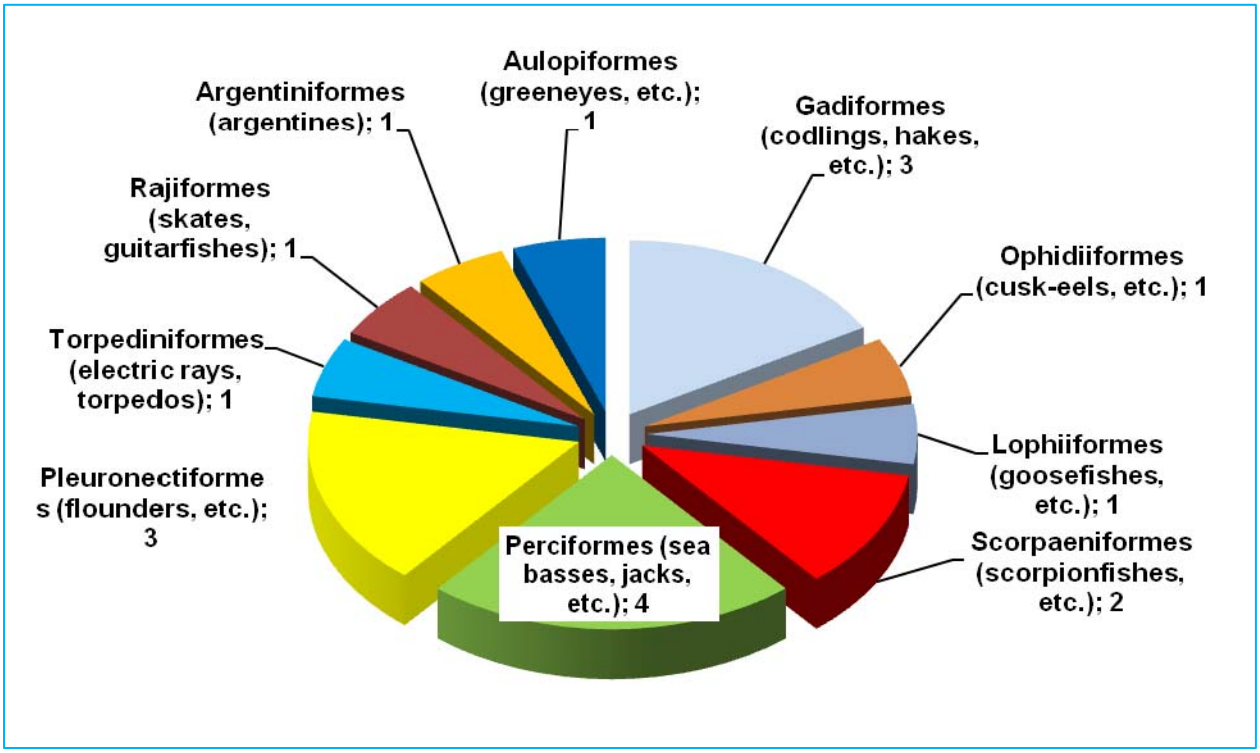
Trawled invertebrates numbered 1,562 individuals belonging to 44 taxa. Fishes numbered 371 and represented 18 species. See Tables 16 and 17 for phylogenetic lists of invertebrate taxa and fish species, respectively. Invertebrates ranged in size from wart barnacles (Verrucidae)

and sea spiders (pycnogonida) to Jonah crabs. Live gastropods were noticeably absent from all trawl samples, although empty shells of Dohrn's volute (*Scaphella dohrni*), Villepin's cone (*Conus villepini*), and a marginella (*Marginella* sp.) were found occupied by hermit crabs, suggesting that at least a few snail species populate the area. Dohrn's volute may live in deeper water than what was sampled during the survey (J.H. Slapcinsky *pers. comm.*). Dominant fish species were those adapted to deep, cool-temperature water; although two warm-water pelagics, the rainbow runner (*Elagatis bipinnulata*) and the bar jack (*Caranx ruber*), were captured when the trawl was briefly at the water's surface during deployment or retrieval. Figure 13 presents images of selected invertebrate taxa and fish species caught by trawl during the survey. In terms of species richness within each major taxonomic group, arthropods and fishes, representing 30.1% and 29.0% of all trawled taxa, respectively, dominated over other major groups. Other groups representing significant percentages of total epifaunal taxa consisted of echinoderms (12.7%) and cnidaria (9.5%) based on phylogeny in Camp et al. (1998), Cairns et al. (2002), Turgeon et al. (1998), and Williams et al. (1989). See Tables 18 and 19 for invertebrate taxa and fish species captured per trawl, respectively. The following pie chart shows numbers of epifaunal taxa by major group collected by trawl during the May 2011 survey.



62 trawled epifaunal taxa by major taxonomic group
(includes all epifaunal trawl samples)

As a group, fishes totaled 15 families representing 10 orders based on phylogeny in Nelson (2006). The order Perciformes was slightly more diverse than other orders (four species, 22.2% of all fish species collected), although two species within this order, the bar jack and the rainbow runner, are pelagic rather than demersal fishes. The following pie chart shows trawled fish species by order.



18 trawled fish species by order
(includes all epifaunal trawl samples)

Total epifaunal densities (individuals per 1,000 m^2) averaged 51.85 per station during the May 2011 survey and ranged from a high of 87.79 at Station PE11-9 (outside the expansion areas) to a low of 30.47 at Station PE11-7 (inside the expansion areas). Night tows averaged a much higher number of individuals per station (mean = 292.75 individuals per tow by night) compared to day tows (mean = 190.50 individuals per tow by day), suggesting that benthos of the slope adhere to defined 24-hour activity patterns despite the low light levels. Bivalves, squid, sipunculid worms, and annelid worms did not significantly affect epifaunal densities at any station, and were absent from one or more trawl samples (the absence of worms being due to gear selectivity).

Total Epifaunal Density per Station[1], Listed by Rank		
Station Number	**Relationship to Expansion Areas**	**Total Epifaunal Density (individuals/1,000 m^2)**
PE11-9	Outside (west of) Expansion Areas	87.79
PE11-6	Inside Expansion Areas	57.86
PE11-8	Outside (south of) Expansion Areas	31.27
PE11-7	Inside Expansion Areas	30.47

[1]See Table 20 for further data and Figure 7 for a visual comparison.

Combining trawl data from multiple stations within a given area, the highest total epifaunal density (individuals per 1,000 m^2) occurred outside of the expansion areas, at 58.78. Table 21 compares densities of major groups in relation to the expansion areas, and Figure 10 offers a visual representation of these parameters. The following summary table presents total epifaunal densities relative to the proposed expansion areas.

Total Epifaunal Density in Relation to the Expansion Areas[1]	
Area of Interest	**Total Epifaunal Density (individuals/1,000 m^2)**
Inside Expansion Areas	42.18
Outside Expansion Areas	58.78

[1]See Table 21 for further data and Figure 10 for visual comparisons.

Shannon diversity index values ranged from a high of 2.08 at Station PE11-9 (outside the expansion areas) to a low of 1.54 at Stations PE11-7 and PE11-8. The relatively low diversity index values found at the four stations sampled may at least partially be a function of trawl performance, which was difficult to discern at such deep depths and over soft sediment. The fact that all station diversity values are well above 1.0 suggests that these stations were relatively devoid of biologically significant pollution or degradation (Türkmen and Kazanci 2010). Pielou evenness (r = 0.9960) and Margalef richness (r = 0.8808) index values show a strong positive correlation with Shannon diversity index values. Table 22 offers community parameters of pooled trawl samples per station. A summary of index values follows.

Mean Epifaunal Shannon Diversity Values per Sampled Station[1], Listed by Rank			
Station Number	**H' Shannon Diversity Index (log e)**	**J' Pielou Evenness Index**	**D Margalef Richness Index**
PE11-9	2.08	0.58	5.00
PE11-6	1.85	0.53	5.14
PE11-8	1.54	0.48	4.13
PE11-7	1.54	0.48	4.05

[1]See Table 22 for further data.

When comparing pooled samples taken inside the expansion areas with those from outside these areas, the highest mean Shannon diversity index value was found outside the expansion areas, with a value of 1.81. Samples from inside the expansion areas resulted in a mean diversity index value of only 1.69. The following summary compares index values relative to the expansion areas.

Mean Epifaunal Diversity in Relation to the Expansion Areas[1], Listed by Rank			
Area of Interest	**H' Shannon Diversity Index (log e) Values**	**J' Pielou Evenness Index**	**D Margalef Richness Index Values**
Outside Expansion Areas	1.81	0.53	4.57
Inside Expansion Areas	1.69	0.51	4.60

[1]Each index value above represents the mean of two stations (with pooled trawl data) within the area of interest.

4.6.3 Abundant Epifaunal Taxa (Tables 23–25, Figures 9–10)

Abundant epifaunal taxa are defined here as those representing at least 2% of total invertebrates or fishes captured by trawl during the May 2011 survey. Six invertebrate taxa and the same number of fish species fit this definition of abundance. The most abundant invertebrate taxon was the sea star *Coronaster briareus,* representing 56.15% of all trawled invertebrates, totaling 877 individuals, and having an average occurrence of 219.25 individuals per station. The Gulf Stream flounder (*Citharichthys arctifrons*) was the most abundant fish species captured, representing 57.95% of all trawled fishes, totaling 215 individuals, and having an average occurrence of 53.75 individuals per station. All abundant epifaunal taxa are true epibenthic (in the case of invertebrates) or demersal (in the case of fish) species. Table 23 lists all abundant epifaunal taxa, including individuals per taxa and percentages of total invertebrates or fishes captured by trawl.

All six abundant invertebrate taxa were found at all four stations. Abundant fish species were each absent from one or more stations. Station PE11-9 is the only station to have all 12 abundant taxa represented in trawl samples. Station PE11-9 had the highest total abundant epifaunal density (82.28 individuals per 1,000 m^2). Station PE11-7 had the lowest density (27.24 individuals per 1,000 m^2) and lacked five of the six abundant fish species. The argentine (*Argentina georgei*) was found in only one trawl sample, taken from Station PE11-9. Table 24 presents densities per station for abundant taxa and Figure 9 offers a visual comparison of these data.

Abundant taxa densities (individuals per 1,000 m^2) were calculated for the expansion areas and outside these areas by pooling station data. Highest total abundant taxa density was found outside the expansion areas (39.47) compared to within the expansion areas (35.55). Table 25 compares abundant taxa in relation to the expansion areas. Figure 10 visually compares these data. The following table provides a summarized comparison relative to the expansion areas.

Abundant Epifaunal Density in Relation to the Expansion Areas[1], Listed by Rank			
Area of Interest	**Total Abundant Epifauna (individuals/ 1,000 m^2)**	**Abundant Invertebrates (6 taxa) (individuals/1,000 m^2)**	**Abundant Fishes (6 species) (individuals/1,000 m^2)**
Outside Expansion Areas	54.85	39.47	15.38
Inside Expansion Areas	36.98	35.55	1.43

[1]See Table 25 for further data and Figure 10 for a visual comparison.

4.6.4 Managed Taxa (Tables 26–29, Figures 11–12)

A total of 1,268 individuals from 15 managed taxa were captured by trawl during the May 2011 survey. Managed taxa represented 65.6% of all trawled epifauna. SAFMC manages six taxa while the remaining nine are managed by the Florida Fish and Wildlife Conservation Commission (FWC) in federal waters. The sea star *Coronaster briareus* represented the great majority (69.2%, *n* = 877) of managed individuals captured by trawl. No live hard corals (scleractinia) were found in any trawl sample. Although pelagic sargassum (*Sargassum* spp.) was frequently observed from the stern deck of the *Bold*, none were found in trawl samples. The species *Sargassum fluitans* and *S. natans* are managed by SAFMC, although the floating sargassum seen from the ship could not be identified to species. Managed fishes in trawl samples were represented only by one juvenile bar jack.

The Magnuson-Stevens Fishery Conservation and Management Act, reauthorized and signed into law in January 2007, allows states to extend their fishery regulations into federal waters if a particular fishery is not already federally managed (NOAA 2007, eRegulations 2011, L. Gregg *pers. comm.*). FWC has applied its state regulations in federal waters for some, but not all, of its fisheries (eRegulations 2011, FWC 2011, L. Gregg *pers. comm.*). The state-managed taxa presented and discussed in this section are those which are currently managed in federal waters adjacent to Florida. These taxa consist of Marine Life Species under Chapter 68B-42.001 F.A.C. (species harvested live for the aquarium trade). In addition, the management of hydroids, soft corals, and sea anemones in federal waters is planned to be handed over to FWC from SAFMC by early 2012 once federal rules are modified to accommodate this change (L. Gregg *pers. comm.*). As of this writing, hydroids, soft corals, and sea anemones continue to be managed by SAFMC.

Managed Taxa Captured by Trawl during the May 2011 Survey[1]		
Scientific Name (common name or vernacular)	**Management Agency**	**Total Number Captured, Notes**
Hydrozoa: Hydroidolina (hydroids)	SAFMC[2]	*n* = 6
Hydrozoa: Hydroidolina, Species A (feathery hydroids)	SAFMC[2]	*n* = 7
Hydrozoa: Hydroidolina, Species B (branching hydroids)	SAFMC[2]	*n* = 2
Alcyonacea (true soft corals)	SAFMC[2]	*n* = 3
Actiniaria (sea anemones)	SAFMC[2]	*n* = 274, second most abundant invertebrate taxa captured
Diogenidae (left-handed hermit crabs)	FWC[3]	*n* = 20
Paguridae (right-handed hermit crabs)	FWC[3]	*n* = 7
Coronaster briareus (a sea star)	FWC[3]	*n* = 877, most abundant taxa captured
Sclerasterias contorta (a sea star)	FWC[3]	*n* = 62, fifth most abundant invertebrate taxa captured
Anthenoides piercei (a sea star)	FWC[3]	*n* = 2
Cheiraster sp. (a sea star genus)	FWC[3]	*n* = 2
Astrogomphus vallatus (basket star)	FWC[3]	*n* = 2
Lytechinus variegatus (green sea urchin)	FWC[3]	*n* = 2
Spatangoida (heart urchins)	FWC[3]	*n* = 1
Caranx ruber (bar jack)	SAFMC[2]	*n* = 1, 37 mm SL juvenile

[1]See Tables 26 through 29 for managed taxa per station and inside versus outside the expansion areas.
[2]SAFMC = South Atlantic Fishery Management Council, which includes Florida's east coast federal waters.
[3]FWC = Florida Fish and Wildlife Conservation Commission, which includes Florida waters and adjacent federal waters for the taxa indicated above.
SL = standard length

Station PE11-9 (outside the expansion areas) had the highest density of managed taxa (47.34 individuals per 1,000 m^2) and the largest number of managed individuals (*n* = 481 individuals from eight taxa) of any station. Station PE11-8 (outside the expansion areas) had the lowest density of managed taxa (21.27 individuals per 1,000 m^2) and lowest number of individuals (*n* = 228 from five taxa). Tables 26 and 27 provide summaries of managed individuals per station and densities of managed taxa per station, respectively. Figure 11 provides a visual comparison of total managed taxa densities per station. The following table summarizes these data.

Total Managed Taxa per Station[1], Listed by Rank			
Station Number	**Relationship to Expansion Areas**	**Total Density (individuals/1,000 m²)**	**Total Individuals (*n* =)**
PE11-9	Outside Expansion Areas	47.34	481
PE11-6	Inside Expansion Areas	45.29	324
PE11-7	Inside Expansion Areas	24.52	235
PE11-8	Outside Expansion Areas	21.27	228

[1]See Tables 26 and 27 for further data and Figure 11 for a visual comparison.

When pooled samples taken within the expansion areas were compared with those taken outside these areas, total density of managed taxa was similar inside and outside the expansion areas (range = 33.40 to 33.96 individuals per 1,000 m^2). Samples from outside the expansion areas had somewhat more managed individuals (*n* = 709) compared to samples from inside these areas (*n* = 559), but the difference does not appear significant. Tables 28 and 29 provide numbers of managed individuals relative to the expansion areas and densities of managed taxa relative to the expansion areas, respectively. Figure 12 provides a visual comparison of total managed taxa densities relative to the expansion areas. The following table summarizes these data.

Total Managed Taxa Density in Relation to the Expansion Areas[1], Listed by Rank		
Relationship to Expansion Areas	**Total Density (individuals/1,000 m²)**	**Total Individuals (*n* =)**
Outside Expansion Areas	33.96	709
Inside Expansion Areas	33.40	559

[1]See Tables 28 and 29 for further data and Figure 12 for a visual comparison.

Sea anemones were found attached to trash such as bottles and cans, but were also found unattached when recovered from trawl samples. The 37 mm SL juvenile bar jack was likely associated with sargassum at the water's surface (Smith-Vaniz 2002). The bar jack is the most abundant jack of the genus *Caranx* in the western central Atlantic (Smith-Vaniz 2002).

Trawl-caught species of management interest are augmented here with species identified in Freeman and Walford (1976). These authors found several managed species not collected in the present study along Florida's east coast including the vicinity of the expansion areas. According to Freeman and Walford (1976), federally managed species found in the vicinity of the expansion areas include amberjacks (*Seriola* spp.), vermillion snapper (*Rhomboplites aurorubens*), dolphinfish (*Coryphaena hippurus*), gag (*Mycteroperca microlepis*), red grouper (*Epinephelus morio*), Goliath grouper (*Epinephelus itajara*), swordfish (*Xiphias gladius*), sailfish (*Istiophorus platypterus*), and even blue marlin (*Makaira nigricans*). The above species can be roughly divided into two groups, the reef-dwelling species (e.g., groupers, snappers) and pelagic species (billfishes, swordfish, etc.). The species mentioned above are managed by SAFMC or NMFS.

Deepwater demersal fishes, including several managed species, were discussed by Parker and Mays (1998), whose study area included the outer continental shelf and upper slope off southeastern Florida. These authors stated that water 100 to 175 m (328 to 656 feet) deep, including off Fort Lauderdale, includes habitat for snowy grouper (*Epinephelus niveatus*), yellowedge grouper (*E. flavolimbatus*), warsaw grouper (*E. nigritus*), and blueline tilefish (*Caulolatilus microps*) based on commercial and recreational landings data and interviews with fishers. Parker and Mays (1998) further stated that golden tilefish (*Lopholatilus chamaeleonticeps*) habitat occurred in water depths between 175 and 300 m (574 to 984 feet) in the area based on commercial and recreational fishing data. None of the species mentioned by these authors were captured within the expansion areas during the May 2011 survey; however, the possible occurrence of these species cannot be ruled out.

4.6.5 Community Structure Based on Trawl Catches

The May 2011 survey revealed that sea anemones are perhaps the most important cnidarians of the epibenthic community based on trawl densities. No sponges (porifera) were collected, suggesting that they are relatively unimportant to the softbottom community. The complete absence of live gastropods in trawl samples is significant, as this group provides forage for a great many fish species. For example, Randall (1967) found that 71 fish species fed on gastropods, and 10 fish species ate gastropod larvae, in his study of the feeding habits of West Indian reef fishes. It may be that the absence of this group is partially a function of gear selectivity as many species spend considerable time buried in sediment. Based on the empty shells carried by hermit crabs in trawl samples, at least three species of gastropods had in recent times populated the area (and may still do so). The sea star *Coronaster briareus* was by far the most abundant echinoderm captured by trawl. ANAMAR was able to verify the tentative identification made by Germano & Associates (2006) of *Coronaster briareus* in plan-view camera images from inside the Port Everglades Harbor ODMDS. This species, along with the sea star *Sclerasterias contorta*, are important members of the epibenthic community and likely help churn the uppermost layer of sediment while foraging. Further, these species may act as both predator (of bivalves) and prey (of crabs and fishes) in the area. Sea urchins were largely absent from trawl samples except for two individuals of the green sea urchin (*Lytechinus variegatus*) and one individual heart urchin (spatangoida), and their roles in the epibenthic community may be partially replaced by other echinoderms. Of the arthropods, penaeid shrimp were noticeably absent from the May 2011 trawl samples, but this may be a result of seasonal abundance variables. The larger crabs such as the Jonah crab and the bathyal swimming crab probably serve important roles as predators and scavengers in the area. Crustaceans are also important prey items within the slope benthos. For instance, a young rosette skate (*Leucoraja garmani*) from a tissue trawl at Station PE11-14 had crustacean remains in its stomach during a dissection by an ANAMAR biologist (see Appendix H for notes on dissections).

Of the fishes, perhaps the most important based on trawl catches is the Gulf Stream flounder, which was by far the most abundant fish caught (see Section 4.6.3 for details), including many mature individuals of this small species. Based on abundance data, other important fish caught include the highfin scorpionfish and the fawn cusk-eel. The fawn cusk-eel, like other members of the family Ophidiidae, blurs the distinction between infauna and epifauna by burrowing into the soft substrate for shelter by day and feeding on or above the bottom after dark. Nearly all (98.7%) of the 76 fawn cusk-eels sampled during this survey were captured at night. This suggests the use of zeitgebers such as photoperiod to maintain a circadian rhythm in the depths sampled, rather than subscribing to a freerunning rhythm that does not adhere to the

24-hour light-dark cycle. Spotted hake captured in the May 2011 survey were all large juveniles and may occur only seasonally in and around the expansion areas as the species is considered a continental shelf species and migrates both north-south and inshore-offshore (Klein-MacPhee 2002). The species may use the area as a foraging ground for benthic invertebrates and fishes. The spotted hake is in turn fed upon by larger hakes (*Urophycis* spp.) along with sand flounders (Paralichthyidae) and goosefishes (Lophiidae) (Klein-MacPhee 2002).

The presence of the blind torpedo in trawl samples in depths of about 735 feet or less was somewhat surprising, as the species is better known from deeper water (approximately 899–3,027 feet, McEachran and de Carvalho 2002). Although Bigelow and Schroeder (1953) suggested that the species exhibits ontogenetic partitioning by water depth, with adults living farther downslope and in greater depths than juveniles, this theory was not supported by the present study as mature individuals of both sexes were captured along with many juveniles at the same stations and depths during the survey. Although very little is known of reproductive habits of this species, dissections made by an ANAMAR biologist on trawl-caught blind torpedoes found that three females, ranging in size from 337 to 379 mm total length and weighing between 330.7 and 432.3 grams, were mature (although non-gravid) based on development of uteri and presence of large oocytes in the ovaries. Those females which measured 304 mm total length or smaller appeared to be immature. A male blind torpedo which measured 291 mm total length and weighed 215.6 grams was mature based on dissections and external anatomy (i.e., calcified claspers), but no spermatocysts were found in its vesicles, suggesting no recent mating activity. Although several blind torpedoes had material in their gut during dissections, the prey items could not be identified. The blind torpedoes and the rosette skates appear to be using the area as foraging grounds. Most of the fishes and many of the invertebrates captured during the trawl survey are potential prey for such deepwater apex predators as the sharpnose sevengill shark (*Heptranchias perlo*) and bluntnose sixgill shark (*Hexanchus griseus*).

4.7 Nonindigenous Species

The occurrence of nonindigenous species is of interest to this study as they may proliferate when a site is altered with the addition of dredged material (Science Applications International Corporation 1986, Pequegnat et al. 1990). The importance of the study of invasion ecology has been recognized by scientists since at least the late 1950s (Elton 1958). Florida is strongly affected by nonindigenous species due to its distinctive geography, subtropical climate, history, and economy (Lachner et al. 1970, U.S. Congress Office of Technology Assessment 1992). An effort was made to identify any trawled epifaunal or grab-sampled benthic infaunal species collected during the survey that are not indigenous to the northwest Caribbean region, which includes Florida's east coast (Abbott 1962, Baker et al. 2004). The U.S. Geological Survey online database of aquatic nonindigenous species and other sources were used.

No nonindigenous species were identified from faunal lists of trawl-caught invertebrates and fishes and grab-sampled benthic infaunal invertebrates. However, it is possible that nonindigenous species were captured during the survey but were not identified as such. Nonindigenous species may not have been identified if the species' native range is not fully understood ('crytogenic' species) or if identification was not pursued to the species level for practical reasons. Addressing nonindiginous species potentially found at the expansion areas is beyond the scope of this report given the large number of species introduced to Florida marine

waters and the continued addition of newly introduced species. The interested reader is invited to use any of the following resources to learn more:

U.S. Geological Survey nonindigenous aquatic species online database:

http://nas.er.usgs.gov

Invasive Species Specialist Group global invasive species online database:

http://www.issg.org/database/welcome

Introduction to invasion ecology and list of contacts:

Jacoby, C., L. Walters, S. Baker, and K. Blyler. 2005. *A Primer on Invasive Species in Coastal and Marine Waters*. Florida Sea Grant College Program Publication SGEB 60, Gainesville, FL. (Available online at: http://edis.ifas.ufl.edu/pdffiles/SG/SG07500.pdf)

Waterproof guide to nonindigenous marine fishes of Florida with color photos and range maps:

Schofield, P.J., J.A. Morris, and L. Akins. 2009. *Field Guide to Nonindigenous Marine Fishes of Florida*. NOAA National Ocean Service, National Centers for Coastal Ocean Science Technical Memorandum NOS NCCOS 92. (Available free from Dr. Pamela Schofield at pschofield@usgs.com)

4.8 Tissue Analysis Results (Table 30, Appendix G)

Edible tissues were extracted from Jonah crabs and spotted hake from May 2011 trawl samples for bioaccumulation analysis. Bioaccumulation occurs whenever a contaminant is retained by an organism, regardless of the route of exposure, and is the net result of absorption, ingestion, respiration, metabolic biotransformation, growth dilution, and excretion/elimination from the organism (Arnot and Gobas 2006). The assessment of bioaccumulation allows the evaluation and determination of risk levels that toxic contaminants in the environment may pose to humans and the environment (Arnot and Gobas 2006). Tissue extractions were conducted May 5 and 6, 2011, onboard the *Bold*. Between 3 and 5 specimens were used in each Jonah crab sample, and 5 to 17 specimens were used in each spotted hake sample. Investigative analyses were performed for certain metals, PAHs, organochlorine pesticides, organotins, and PCB congeners of interest to this study, as well as total lipids and total solids. Four additional trawl tows were conducted at Stations PE11-5, PE11-13, and PE11-14, as well as a tow conducted southwest of the expansion areas. These additional tows were used to supplement tissue extracted from specimens collected during epifaunal trawl sampling.

Full analyses were conducted on each sample or composite. Spotted hake and Jonah crab tissue from Stations PE11-5 and PE11-10 were composited by taxa. Spotted hake tissue from Stations PE11-6 and PE11-7 were also composited to provide adequate mass. Composite samples are referred to here by linking associated stations using a hyphen (example: composited Jonah crab sample from Stations PE11-5-10). A field split sample was taken from a spotted hake sample from Station PE11-9. Laboratory QA/QC, in the form of matrix spike and duplicate matrix spike analysis, was also conducted. Table 30 provides metric data on tissue-sampled species by station and sample ID. Appendix G consists of a full laboratory report of tissue analysis results. The following summary table shows taxa sampled by station and analyses performed.

May 2011 Tissue Sampled Species and Analyses by Station Number[1]		
Station Number(s)[2]	**Species**	**Notes, Analyses Conducted**
PE11-5-10	Spotted hake	Composited; metals, lipids, PAHs, pesticides, organotins, and PCBs
PE11-5-10	Jonah crab	Composited; metals, lipids, PAHs, pesticides, organotins, and PCBs
PE11-6-7	Spotted hake	Composited, metals, lipids, PAHs, pesticides, organotins, and PCBs
PE11-9	Spotted hake	Incl. field split sample; metals, lipids, PAHs, pesticides, organotins, and PCBs
PE11-9	Jonah crab	Metals, lipids, PAHs, pesticides, organotins, and PCBs
PE11-14	Jonah crab	Metals, lipids, PAHs, pesticides, organotins, and PCBs

[1]See Table 30 for a complete summary.
[2]The tissue trawl from Station PE11-10 (involving two composite samples) was not conducted at Station PE11-10 as intended, but was instead conducted southwest of the expansion areas. Station numbers having more than one hyphen indicate composited samples from two stations.

Jonah crabs used for tissue analysis had a mean carapace width of approximately 120 mm and included individuals of both sexes. These crabs were either functionally mature or nearly so based on size-at-maturity data given in Robichaud and Frail (2006) for western North Atlantic stocks. Spotted hake used for tissue analysis had a mean standard length of about 200 mm and many were female as observed during tissue extractions. These fish were immature based on length at maturity data presented in Klein-MacPhee (2002). The two taxa are discussed separately for most analytes tested considering differences in ecological, physiological, and life history characteristics that affect bioaccumulation of contaminants.

4.8.1 Total Lipids (Table 31)

Jonah crab samples had a mean total lipid concentration of 0.43% while spotted hake samples had a slightly lower mean lipid concentration (0.35%). The highest lipid concentration (0.59%) was found in a Jonah crab sample collected from Station PE11-14 inside the proposed expansion areas. The following table presents a summary of lipid concentrations by species and station. Table 31 includes a complete summary of total lipid results.

Summary of Total Lipid Concentration Results by Species[1]			
Station Number(s)	**Notes**	**Total Lipids (%)**	**Relation to Expansion Areas**
Jonah Crab			
PE11-5-10	Composite Sample	0.35	Outside Expansion Areas
PE11-9	–	0.35	Outside Expansion Areas
PE11-14	–	0.59	Inside Expansion Areas
Spotted Hake			
PE11-5-10	Composite Sample	0.33	Outside Expansion Areas
PE11-6-7	Composite Sample	0.37	Inside Expansion Areas
PE11-9	–	0.38	Outside Expansion Areas
PE11-9	Field Split Sample	0.33	Outside Expansion Areas

[1]See Table 31 for a complete summary of total lipid concentrations.

4.8.2 Relationship between Lipids and Lipophilic Contaminants

Lipophilic contaminants, such as PCBs and certain pesticides, can accumulate in lipids and remain until the fat deposit is burned as energy (Pequegnat et al. 1990) or converted to reproductive cells. Thus, lipid concentration is a measure of the ability of an organism to store such lipophilic contaminants. When fish convert lipids to developing ova, contaminants such as mercury (in the form of methylmercury) can also be transferred to the eggs (Alvarez et al. 2006). Maternal transfer of methylmercury to egg biomass was estimated to be between 2% and 11% of total mercury in female walleye (*Stizostedion vitreum*) muscle tissue in a study by Latif et al. (2001). Maternal transfer of methylmercury may substantially lower survival of fish larvae by altering predator-avoidance behaviors compared to unexposed larvae based on a laboratory study by Alvarez et al. (2006) using Atlantic croaker (*Micropogonias undulatus*). The findings of the Alvarez et al. (2006) study also suggest that bioaccumulation of such analytes by apex predators such as marlin may cause mortality in larvae by maternal transfer.

A study by Iannuzzi et al. (2004) of the highly contaminated Passaic River along the New York-New Jersey border found that lipid concentrations were not strongly correlated to contaminant concentrations in blue crab or mummichog (*Fundulus heteroclitus*) tissue. However, the study did find that lipid concentrations accounted for some of the variability in contaminant levels in white perch (*Morone americana*) tissue. The Iannuzzi et al. (2004) study differed from the present study in the use of whole carcasses in their sampling scheme. A study by NOAA (1989) found no significant correlation between lipid and contamination concentrations in mussels and oysters taken from 177 sites in coastal waters across the continental United States, with the exceptions of chlordane and dieldrin, which showed significant correlations (r = 0.12). Although NOAA (1989) stated that outside of these two analytes, lipid concentrations "are not related to the organic contaminant levels", many researchers consider lipid concentrations to play a role in bioaccumulation of lipophilic contaminants in organisms.

4.8.3 Bioaccumulation of Metals and Organotins (Table 31)

Jonah Crab—Of the three Jonah crab samples tested, most metal and all organotin results were well below the FDA level for crustacea. The exception was arsenic, which resulted in concentrations of 106 to 122 mg/kg in the three crab samples, exceeding the FDA level of 76

mg/kg for this analyte. The highest arsenic concentration originated from a sample taken at Station PE11-14, inside the proposed expansion areas. All nine metal analytes tested were detected in levels greater than the MDL. The reader is reminded that the limit for arsenic in tissues was recently removed from the FDA list (see FDA 2011 for details) but is used for comparison purposes here. The organotin cations tested resulted in non-detects in the three Jonah crab samples, and the total organotin concentrations (as tin) were calculated from the MDL. Most (55.6%) of the maximum detected concentrations of the metals analyzed came from stations outside the proposed expansion areas. Metal and organotin concentrations in Jonah crab tissue are summarized below in relation to the proposed expansion areas. Table 31 provides a complete summary.

JONAH CRAB: Summary of Bioaccumulated Wet Weight Metal and Organotin Results, Excluding Non-Detected Analytes[1]

Analyte	Range of Values		FDA Action Levels: Crustacea (mg/kg)
	Inside Expansion Areas (mg/kg)	Outside Expansion Areas (mg/kg)	
Arsenic	**122**	**106–117**	76
Cadmium	0.0170	0.0244–0.0494	3
Chromium	0.06	0.05–0.07	12
Copper	12.0	7.580–13.6	x
Lead	0.0243	0.0223–0.0257	1.5
Mercury	0.2764	0.1406–0.2578	1
Nickel	0.188	0.140–0.183	70
Silver	0.240	0.162–0.208	x
Zinc	66.4	65.1–71.3	x

[1]See Table 31 for a complete summary of analytical results for metals and organotins. One sample was tested from inside the expansion areas and two samples were tested from outside the expansion areas.
Numbers in bold denote a value greater than or equal to the FDA action level for crustacea.
x = No FDA level published for analyte.

Spotted Hake—Of the three spotted hake samples plus a field split sample tested, concentrations were detected above the MDL in all metals except silver, which was not detected in any sample. No organotin cations were detected in any spotted hake sample, and the total organotin concentrations (as tin) were calculated from the MDL. Maximum detected concentrations of all eight detected metals came from stations outside the proposed expansion areas. All spotted hake sample mercury concentrations were well below the 1 mg/kg FDA criteria for the mercury component of methylmercury stated in the FDA Compliance Policy Guide Section 540.600. Concentrations of cadmium, copper, lead, and zinc in spotted hake samples were well below the concentrations, 0.35 mg/kg (cadmium), 4.5 mg/kg (copper), 4 mg/kg (lead), and 55 mg/kg (zinc), suspected to cause adverse effects in bluegill (*Lepomis macrochirus;* Cearley and Coleman 1974), rainbow trout (*Oncorhynchus mykiss;* Mount et al. 1994), brook trout (*Salvelinus fontinalis;* Holcolme et al. 1976), and flagfish (*Jordanella floridae;* Spehar et al. 1978), respectively.

The antagonistic relationship between bioaccumulated selenium and mercury toxicity in organisms has been documented both in the laboratory and in field studies but the exact

relationship between the two metals remains poorly understood and in need of further research (Cuvin-Aralar and Furness 1991). It has been suggested that selenium provides a protective effect over mercury toxicity, although a possible protective action of mercury over selenium has also been suggested (Cuvin-Aralar and Furness 1991). It is clear that further research is required to better understand this relationship. Since fishes generally tend to bioaccumulate both these analytes, knowledge of this relationship on the cellular level is important to our understanding and predicting the effects of mercury toxicity in the environment and in the consumer.

Current Florida Department of Health guidelines recommend that the consumption of fish species having less than 0.5 mg/kg (converted from parts per million) of total mercury should follow EPA guidelines, and fish containing 0.5 to 1.5 mg/kg total mercury should be consumed only in limited quantities (Adams et al. 2003). The Florida Department of Health further advises that fish species containing greater than 1.5 mg/kg of total mercury not be consumed in any amount. In the present study all spotted hake mercury concentrations were well below the 0.5-mg/kg threshold and therefore should be consumed following EPA guidelines. No hakes were sampled by the Florida Fish and Wildlife Conservation Commission (FWC) in an ongoing study of mercury concentrations in 108 Florida fish species representing 40 families (Adams et al. 2003), so comparisons could not be made. FWC is currently analyzing hake tissue from Florida waters for mercury but the date of publication remains uncertain (D.H. Adams *pers. comm.*). The following is a summary of spotted hake bioaccumulated metal and organotin concentrations in relation to the expansion areas. See Table 31 for a complete summary of results for spotted hake.

SPOTTED HAKE: Summary of Bioaccumulated Wet Weight Metal and Organotin Results, Excluding Non-Detected Analytes[1]

Analyte	Range of Values		FDA Criteria: Fish (mg/kg)
	Inside Expansion Areas (mg/kg)	Outside Expansion Areas (mg/kg)	
Arsenic	31.50	30.90–47.50	x
Cadmium	0.0027	0.0049–0.0051	x
Chromium	0.05	0.06–0.13	x
Copper	0.145	0.154–0.221	x
Lead	0.0133	0.0136–0.0208	x
Mercury[2]	0.0948	0.1758–0.2204	1
Nickel	0.039	0.042–0.059	x
Zinc	3.10	2.79–3.17	x

[1]See Table 31 for a complete summary of metal and organotin analysis results. One sample was tested from inside the expansion areas and three were tested from outside the expansion areas.

[2]The FDA criteria of 1 mg/kg is for the mercury component of methylmercury. No other FDA criteria currently exist applicable to spotted hake or other fish species and metals.

x = No FDA criteria published for analyte.

Taking both tissue-sampled species into consideration, the only analyte concentration to exceed applicable FDA levels was arsenic, which exceeded this limit in the three Jonah crab samples tested, including inside and outside the proposed expansion areas. Although there are some

differences in total numbers of maximum detected analytes in relation to the expansion areas, mainly with spotted hake samples, these differences do not appear to be significant and could be explained by the low sample size per species.

4.8.4 Bioaccumulation of Organochlorine Pesticides (Table 32)

Overall, only 3 (12.0%) of the 25 organochlorine pesticides tested were detected among the samples analyzed, regardless of species.

Of the three Jonah crab samples analyzed, the samples from Stations PE11-9 (outside the expansion areas) and PE11-14 (inside the expansion areas) had J-qualified concentrations of 0.68 and 0.51 µg/kg, respectively, for p,p' (4,4')-DDE. No sample exceeded the FDA level for crustacea. All other analyte concentrations resulted in non-detects.

Of the three spotted hake samples plus a field split sample analyzed, a total of three analytes were detected in J-qualified amounts of 0.71 µg/kg or less while the remaining analytes resulted in non-detects. All three detected analytes originated from stations outside of the expansion areas. There are currently no FDA levels for fish tissue concentrations of the analytes tested. The following summary shows the range of concentrations of organochlorine pesticides in relation to the expansion areas, excluding non-detected analytes (see Table 32 for a complete summary).

ALL SPECIES: Summary of Detected Concentrations of Bioaccumulated Wet Weight Organochlorine Pesticides, Excluding Non-Detected Analytes[1]

Analyte[2]	Range of Values: Inside Expansion Areas (µg/kg)	Range of Values: Outside Expansion Areas (µg/kg)	FDA Action Level: Crustacea (µg/kg)
Jonah Crab			
p,p' (4,4')-DDE	0.51	<0.45–<0.45	5000 (for DDD, DDE, and DDT individually or in combination)
Spotted Hake			
p,p' (4,4')-DDE	<0.45	<0.45–0.71	Not applicable
p,p' (4,4')-DDT	<0.49	<0.49–0.49	Not applicable
β-BHC	<0.41	<0.41–0.41	Not applicable

[1]See Table 32 for a complete summary of organochlorine pesticide analysis results.
[2]Each analyte in the above table was detected in one sample per species, or less.
"<" less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).
x = No FDA level published for analyte.

Of the 25 pesticides tested, the majority (92.0%) resulted in non-detects for all samples. Of the three detected analytes, all were detected in only J-qualified concentrations. None of the pesticide concentrations approached the FDA level for crustacea. The results suggest no significant differences in bioaccumulated organochlorine pesticide concentrations in the two species sampled inside and outside the expansion areas and between stations.

4.8.5 Bioaccumulation of Polynuclear Aromatic Hydrocarbons (Table 33)

Overall, 38.9% of the 18 PAH analytes tested were detected above the MDL. Of these seven, all were detected below the MRL (J-qualified). There is currently no FDA level applicable to the sampled species and PAHs tested here. Phenanthrene was detected in all three Jonah crab samples (in J-qualified concentrations) and was the only analyte detected in this species. The spotted hake sample from Station PE11-9 (outside the expansion area) resulted in all seven analytes detected and had the maximum detected concentration of five of these. Interestingly, no analyte was detected in the field split of this sample. By comparison, the spotted hake sample taken from inside the expansion areas (composited from Stations PE11-6 and PE11-7) had only two PAHs detected and one maximum detected concentration. Phenanthrene was detected in five of the seven samples analyzed, while the remaining detected analytes were found in only one or two samples each. Detected concentrations of PAHs in Jonah crab and spotted hake tissue samples are summarized in the following table (see Table 33 for a complete summary).

ALL SPECIES: Summary of Detected Concentrations of Bioaccumulated Wet Weight PAH Results, Excluding Non-Detected Analytes[1]

Analyte	Range of Values	
	Inside Expansion Areas (µg/kg)	Outside Expansion Areas (µg/kg)
Jonah Crab		
Phenanthrene[2]	0.42	0.42–0.45
Total LMW[3] PAHs	3.06	3.01–3.36
Total HMW[3] PAHs	1.80	1.77–1.98
Total PAHs	6.70	6.59–7.36
Spotted Hake		
Benzo(a)anthracene	<0.20	<0.19–0.46
Benzo(b)fluoranthene	<0.35	<0.33–0.57
Chrysene	<0.29	<0.28–0.44
Fluoranthene	<0.26	<0.25–0.42
Naphthalene	0.95	<0.75–0.76
Phenanthrene	0.36	<0.33–0.41
Pyrene	<0.26	<0.26–0.32
Total LMW[3] PAHs	3.24	2.92–3.01
Total HMW[3] PAHs	1.84	1.80–2.44
Total PAHs	6.97	6.62–7.49

[1]See Table 33 for a complete summary of PAH analysis results.
[2]Analyte was detected above the MDL in all three Jonah crab samples.
[3]LMW = low molecular weight; HMW = high molecular weight. See Table 33 for calculations.
"<" Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).

Note: There are currently no FDA action levels available for PAHs in crustacea or fishes.

Of the 18 PAH analytes tested, the majority (61.1%) resulted in non-detects for all samples. Of the seven detected analytes, all were detected in only J-qualified concentrations. Although samples taken from outside the expansion areas held the most maximum detected concentrations of PAHs for both Jonah crab and spotted hake, this is not considered significant since none of the resultant concentrations exceeded the MRL in any sample.

4.8.6 Bioaccumulation of Polychlorinated Biphenyls (Table 34)

The PCB congeners of interest to this study lack any FDA levels for crustacea or fish tissue except for total EPA Region 4 PCBs, which represent tolerance levels rather than an action level (see Table 9-1 in FDA [2001] for details). FDA (2001) and 21 CFR §109.30 do not distinguish between total EPA Region 4 PCBs and total PCBs in tissue. However, this report subscribes to the statement in the SERIM, Appendix H, which suggests that the FDA level is applicable to total EPA Region 4 PCBs.

Overall, only 15.4% of the 26 PCB congeners tested were detected in any tissue sample (Jonah crab or spotted hake), and detected PCBs were in concentrations less than the MRL (J-qualified). Only PCB congeners 118, 138, 153, and 187 were detected. None of the Jonah crab samples approached the FDA tolerance level for total EPA Region 4 PCBs. Similarly, none of the spotted hake samples approached the FDA tolerance level for total EPA Region 4 PCBs in edible fish tissue stated in 21 CFR §109.30. The definition of edible fish tissue in 21 CFR §109.30 includes skin; however, skin tissue was excluded in the present analysis based on guidance in Science Applications International Corporation (1986) and Pequegnat et al. (1990). Total PCB concentrations in spotted hake tissue did not approach the 2700 µg/kg found by Orn et al. (1998) to adversely affect reproduction and survival in the zebra danio (*Danio rerio*), a small cyprinid forage fish. Summaries of detected concentrations of PCB congeners in Jonah crab and spotted hake tissue are offered in the following tables (see Table 34 for a complete summary for both species).

JONAH CRAB: Summary of Detected Concentrations of Wet Weight PCB Results, Excluding Non-Detected PCBs[1]

PCB Congener	Range of Values		FDA Action Level: Crustacea (µg/kg)
	Inside Expansion Areas (µg/kg)	Outside Expansion Areas (µg/kg)	
PCB 118	<0.11	<0.11–0.11	x
PCB 138	0.21	0.16–0.25	x
PCB 153	0.17	<0.13–0.17	x
PCB 187	0.14	0.091–0.17	x

[1]See Table 34 for a complete summary of bioaccumulated PCB analysis results.
"<" Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).
x = No FDA action level published for analyte.
Numbers in parentheses denote a product which included analyte concentrations not detected at or above the MDL (see Table 34 for details).

SPOTTED HAKE: Summary of Detected Concentrations of Wet Weight PCB Results, Excluding Non-Detected PCB Congeners[1]			
	Range of Values		FDA Tolerance Level: Edible Portions of Fish (µg/kg)
PCB Congener	Inside Expansion Areas (µg/kg)	Outside Expansion Areas (µg/kg)	
PCB 118	<0.11	<0.11–0.11	x
PCB 138	<0.091	0.10–0.23	x
PCB 153	<0.13	<0.13–0.45	x
PCB 187	<0.083	0.083–0.17	x

[1]See Table 34 for a complete summary of bioaccumulated PCB analysis results.
"<" Less-than symbol indicates analyte was not detected at or above the MDL for one or more samples (number indicates the lowest MDL).
x = No FDA tolerance level published for analyte.

Of the 26 PCB congeners tested, 22 (84.6%) resulted in non-detects for all samples. Of the four detected analytes, all were detected in only J-qualified concentrations. Three of the four detected congeners were found both inside and outside the expansion areas. No sample met or exceeded FDA tolerance levels. There were no strong differences between candidate sites based on these results.

4.8.7 Additional Factors Affecting Bioaccumulation

Accumulation patterns of metals and other contaminants can vary significantly even among taxa sharing the same major taxonomic group and this point should not be overlooked when comparing tissue analysis data. For example, barnacles (cirripedia) are known to accumulate zinc from solution without any significant amount of excretion (Rainbow 2007). All zinc taken in by the diet of a barnacle accumulates in the body as zinc pyrophosphate granules and results in some of the highest accumulated concentrations (e.g., to at least 50,000 mg/kg) of any metal in any taxa (Rainbow 2007). On the opposite end of the spectrum is the grass shrimp, *Palaemon elegans,* which shares the class crustacea with barnacles but is able to regulate its body concentration of zinc at about 90 mg/kg almost regardless of the dissolved concentrations it is exposed to (Rainbow 2007). This is because the rate of uptake is balanced by that of excretion, allowing the body concentration to remain unchanged (Rainbow 2007).

Species-specific bioaccumulation influences are not limited to invertebrates. A study of total arsenic concentrations in marine fish tissue from stocks in the Caribbean and the Mediterranean seas found that species-specific characteristics, rather than geographical location, influenced bioaccumulation levels (Fattorini et al. 2006). It is recommended that future bioaccumulation studies of the Port Everglades Harbor ODMDS select the same species or closely related species to those selected in the present study to allow for proper comparison.

Further, the selection of similar size classes and season of capture (as it relates to reproductive state and maternal transfer of contaminants) may reduce variability somewhat. Positive relationships between bioaccumulated mercury concentrations and fish size (length, weight) and fish age have been documented in Florida populations of red drum (*Sciaenops ocellatus*; Adams and Onorato 2005), spotted seatrout (*Cynoscion nebulosus*; Rider and Adams 2000), and king mackerel (*Scomberomorus cavalla*; Adams and McMichael 2007). Trophic status also

plays an important role. Apex predators such as bull sharks (*Carcharhinus leucas*) have been documented to have up to two orders of magnitude greater PCB concentrations than lower trophic-level fish species in Florida (Johnson-Restrepo et al. 2005). Factors discussed above should be considered when choosing a test subject for future monitoring and comparisons.

5 QA/QC REVIEW

ANAMAR prepared all the tables and charts in this report. Raw data were compiled into tables from electronic data deliverables provided by laboratories, except in the case of trawled epifaunal community parameters, which were produced in-house. All data tables were reviewed for quality control. A different person reviewed the data tables to ensure results, qualifiers, and reporting limits (as applicable) were entered correctly. ANAMAR's QA Officer also verified the quality control results in the laboratory reports and compared them to the QC summary tables in Appendix O of the SERIM. ANAMAR prepared a Chemical Quality Assurance Report (CQAR) summarizing each sediment, water, and tissue analytical group; specific quality control and targets; and an analysis of whether the laboratory met the criteria specified (Appendix I).

All sediment, water, and tissue analyses were performed consistent with the quality assurance program of CAS, except for sediment physical analyses, which were performed consistent with the quality assurance program of MACTEC. This report contains analytical results for samples designated for Tier IV validation deliverables, including summary forms and all of the associated raw data for each of the analyses. When appropriate to the method, method blank results have been reported with each analytical test.

5.1 Sample Receipt

Sediment and water samples were received for analysis at CAS on May 10, 2011. The samples were received in good condition and consistent with the accompanying chain-of-custody form. The samples were stored in a refrigerator at 4°C upon receipt at the laboratory.

Benthic infaunal samples were received for analysis at Barry A. Vittor & Associates, Inc. on May 12, 2011. The samples were received in good condition and consistent with the accompanying chain-of-custody form. The samples were stored at room temperature and submerged in the fixative NOTOXhisto® upon receipt at the laboratory.

Physical samples were received for analysis at MACTEC in Jacksonville, Florida, on May 10, 2011, for grain size and total solids analysis. The samples were received in good condition and consistent with the accompanying chain-of-custody form.

5.2 General Chemistry Parameters

No anomalies associated with the analysis of these samples were observed.

5.2.1 Total Metals

Relative Standard Difference Exceptions—The relative standard deviation (RSD) for the replicate analysis of copper and lead in sample PE11-1-SED was outside the normal CAS control limits (37% and 33% RSD, respectively, versus a control limit of 30%). The variability in the results was attributed to the heterogeneous character of the sample. Standard mixing techniques were used but were not sufficient for complete homogenization of this sample.

Method Blank Exceptions—Lead slightly exceeded the MRL (0.051 in method blank [MB] versus 0.051 in the MRL).

No other anomalies associated with the analysis of these samples were observed.

5.2.2 Organochlorine Pesticides by EPA Method 8081A

Surrogate Exceptions—The control criteria were exceeded for the surrogate tetrachloro-m-xylene in PE11-3-SED. Since the problem may indicate a potential bias, the sample was re-extracted and re-analyzed 27 days past the recommended hold time. The surrogate met control criteria for the re-analysis. Note that the results for the field samples were comparable for both determinations, which indicated the problem with the initial analysis was restricted to the surrogate recovery. The results from the original and the re-analysis were reported. The data were flagged to indicate the problem.

Elevated Detection Limits—The detection limit was elevated for at least one analyte in most samples. The chromatogram indicated the presence of non-target background components. The matrix interference prevented adequate resolution of the target compounds at the normal limit. The results were flagged to indicate the matrix interference.

Discussion of Sample PE-11-1-SED for 4,4'-DDD—The analysis of sample PE11-1-SED shows an anomalous result for 4,4'-DDD. Based on the concentration in the sample and its matrix spike, the sample was re-analyzed through a screening process and the results are presented below along with a brief discussion of the sample analysis, its relationship to the field split, and the physical nature of the sample.

Matrix Spike and Spike Duplicate—Initially, the laboratory re-ran the PE11-1-SED sample due to poor spike recoveries in the MS/MSD. The concentration in the sample was 160 µg/kg, with concentrations in the MS and MSD samples of 119 and 11 µg/kg and a spike concentration of 14.8 µg/kg, yielding spike recoveries of -285% and -1,014%. Since the concentration of the spiked amount is known, subtracting that value from the spike result can provide an estimate of the sample concentration; for this sample the estimates are approximately 104 µg/kg and ND, respectively.

The laboratory then ran the analysis two additional times. The results are shown in the table below.

Laboratory Screenings of Analyte 4,4'-DDD in Sediment Sample PE11-1-SED

	Original	Screen 1	Screen 2	Original-MS	Original-DMS
4,4'-DDD concentration (µg/kg)	160	ND	35	119	11
Sample amount extracted (grams)	40.01	10.25	10.11	40.11	40.05
Final extract volume (ml)	4	4	10	4	4
Date extracted	5/17/2011	6/15/2011	6/22/2011	5/17/2011	5/17/2011

The two screens shown were run after the analytical holding time for this method had expired, used less mass for analysis than stated in the method, and did not use any cleanup procedures. These results should therefore be used qualitatively as an indication of heterogeneity and matrix interferences in the sample rather than quantitatively.

Comparison to the Field Split—While in the field, a field split was collected for sample PE11-1-SED, and provided to the laboratory as a blind QC sample. The split sample did not show any detectable concentration of 4,4' DDD.

Physical Nature of Sample PE11-1-SED—Sample PE11-1-SED had a sand concentration of 65.1%, with the remainder consisting of silts and clay. As stated by the laboratory in their case narrative, the sample included a large amount of water and could not be properly homogenized prior to analysis. An examination of the archive samples kept at ANAMAR shows the sample with approximately 1 inch of water on top of 3 to 4 inches of sediment. An attempt to homogenize the samples showed that the sand settled out almost immediately, with a layer of water and fines remaining on top, confirming the laboratory's statement. Also noted in the sediment were small pockets of a darker material.

Further Observations on Sample PE11-1-SED—Based on the spike results and the visual heterogeneity of the samples, the anomalous result for 4,4' DDD is likely the result of matrix interference. Results of the screens and the field split show concentrations ranging from not detected to 160 µg/kg; it may be more appropriate to use the complete range of results for any studies in the future.

No other anomalies associated with the analysis of these samples were observed.

5.2.3 PCB Congeners by EPA Method 8082

Elevated Detection Limits—The detection limit was elevated for at least one analyte in a few samples. The chromatogram indicated the presence of non-target background components. The matrix interference prevented adequate resolution of the target compounds at the normal limit, and the results were flagged to indicate the matrix interference.

Sample Notes and Discussion—The advisory criteria were exceeded for PCB 156 in the standard reference material (SRM). The recovery information reported is for advisory purposes only, i.e., to provide additional information about the performance of these compounds in this matrix. The associated QA/QC results (LCS, MS, MB, calibration standards) indicated the analysis was in control. No further corrective action was required.

The recovery of the surrogate tetrachloro-m-xylene in PE11-3-SED was lower than expected. Since the problem may indicate a potential bias, the sample was re-extracted and re-analyzed. The surrogate recovery was for the reanalysis was within the expected range. Note the results for the field samples were comparable for both determinations, which indicated the problem with the initial analysis was restricted to the surrogate recovery. The results from the original and the re-analysis were reported.

5.2.4 Organotin Compounds

Second Source Exceptions—The analysis of butyltins by the Krone method requires the use of dual column confirmation. When the initial calibration verification (ICV) criteria are met for both columns, the lower of the two sample results is generally reported. This criterion was not met for one column for tri-n-butyltin. The data quality was not affected and no further corrective action was necessary.

No other anomalies associated with the analysis of these samples were observed.

5.2.5 Polynuclear Aromatic Hydrocarbons by EPA Method 8270C

Discrepancies Between Sample PE11-1-SED and its Field Split—As previously noted in Section 5.2.2, sample PE11-1-SED was visually heterogeneous, containing pockets of material that were darker than the dominant sediment and could not properly be homogenized in the laboratory. This is the likely reason for the discrepancies between the sample and its field split.

Sample Notes and Discussion—The advisory criterion was exceeded for benzo(a)pyrene in the SRM. The recovery information reported for these analytes is for advisory purposes only (i.e., to provide additional detail related to the performance of each compound). No further corrective action was required.

No other anomalies associated with the analysis of these samples were observed.

5.3 Site Water: Total Suspended Solids by Standard Method 2540 D

5.3.1 General Chemistry Parameters

No anomalies associated with the analysis of these samples were observed.

5.4 Tissue Analysis

5.4.1 Total Metals

Matrix Spike Recovery Exceptions—The control criteria for matrix spike recovery of arsenic for the spotted hake field split sample (labeled as PE11-11-TIS-A when sent to the laboratory) were not applicable. The concentration in the sample was 33.5 µg/kg, and the spike added was only 2.97 µg/kg. This yielded a recovery of 34% for the spike, but the recovery was likely affected by the low level added compared to the concentration in the sample.

5.4.2 Organochlorine Pesticides by EPA Method 8081A

Sample Notes and Discussion—The advisory criteria were exceeded for several analytes in the SRM. The recovery information reported is for advisory purposes only, i.e., to provide additional information about the performance of these compounds in this matrix. The associated QA/QC results (LCS, MS, MB, calibration standards) indicated the analysis was in control. No further corrective action was required.

Matrix Spike Exceptions—Endrin aldehyde is outside the acceptance limits at 49%; however, it is confirmed by the MSD, indicating that matrix interference was likely the cause.

5.4.3 PCB Congeners by EPA Method 8082

Elevated Detection Limits—The detection limit was elevated for at least one analyte in most samples. The chromatogram indicated the presence of non-target background components. The matrix interference prevented adequate resolution of the target compounds at the normal limit. The results were flagged to indicate the matrix interference. Except for PCB 87 in Jonah crab sample 9-TIS-B, the target detection limits were met for all congeners in all samples, including those which had elevated detection limits due to matrix interferences. The MDL found in sample 9-TIS-B was 1.1 µg/kg, which was slightly above the target detection limit of 1 µg/kg.

Sample Notes and Discussion—The advisory criteria were exceeded for a few analytes in the SRM. The recovery information reported is for advisory purposes only, i.e., to provide additional information about the performance of these compounds in this matrix. The associated QA/QC results (LCS, MS, MB, calibration standards) indicated the analysis was in control. No further corrective action was required.

Matrix Spike Recovery Exceptions—The control criteria for the matrix spike recovery of PCB 87 for the spotted hake field split sample (labeled as PE11-11-TIS-A for laboratory purposes) was not applicable. The chromatogram indicated that non-target matrix background components contributed to the reported matrix spike concentrations. Although the analysis showed matrix interferences, the recovery for both the spike and spike duplicate were within acceptance criteria, indicating the interference was minimal.

5.4.4 Organotin Compounds

Second Source Exceptions—The analysis of butyltins by the Krone method requires the use of dual column confirmation. When the ICV criteria are met for both columns, the lower of the two sample results is generally reported. The primary evaluation criteria were not met on the confirmation column for tri-n-butyltin. The data quality was not affected and no further corrective action was necessary.

Matrix Spike Exceptions—Matrix spike recoveries were low for all compounds; however, they are confirmed by the MSD.

Relative Percent Difference Exceptions—The RPD for n-butyltin in the replicate matrix spike analyses of Jonah crab sample PE11-5-10-COMP-B was outside control criteria. All spike recoveries in the MS, DMS, and associated LCS were within acceptance limits, indicating the analytical batch was in control. No further corrective action was appropriate.

5.4.5 Polynuclear Aromatic Hydrocarbons by EPA Method 8270C

Method Blank—Although all analytes in the method blank were below the method reporting limit, most of them were detected and approximately half were above 1 µg/kg.

Continuing Calibration Verification Exceptions—Benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene are both slightly outside limits at 17% difference.

Relative Percent Difference Exceptions—The RPDs for dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene in the replicate LCS analyses were outside control criteria. The recovery in the LCS was above the upper control limit, which equates to a potential high bias. The compounds in question were not detected in the associated samples. The data were flagged to indicate the problem.

5.5 Physical Parameters

A review of the results confirmed that the QC criteria for the physical analysis of sediment were met for all samples.

5.6 Benthic Infaunal Samples

All benthic infaunal samples were analyzed in accordance with Barry Vittor & Associates laboratory SOP. Verification of taxonomic determinations and assemblage parameters were conducted by the Barry Vittor & Associates laboratory and met all applicable QA/QC criteria.

5.7 Epifaunal Trawl Samples

Epifaunal sample taxonomic determinations were made by an ANAMAR biologist with the assistance of scientists and taxonomists from FLMNH at the University of Florida. All sample statistical analyses were performed by ANAMAR in accordance with procedures outlined in the May 2011 survey QAPP document.

Based on photographs taken in May 2011 of the benthos in and around the ODMDS, hydroids may be more common in the area than indicated by trawl sample abundance. It is possible that the trawl passed over these organisms without collecting them. In this case, the hydroid densities described in Section 4.6.4 may be considered conservative values. Additionally, fish species including the blackbelly rosefish (*Helicolenus dactylopterus*) and the yellowfin bass (*Anthias* cf. *nicholsi*) were represented in May 2011 photographic data of the benthos but were absent from trawl catches, suggesting that some epifauna may successfully avoid the trawl.

6 CONCLUSIONS

Physical, chemical, and biological data were obtained from stations in and around the proposed expansion areas and the Port Everglades Harbor ODMDS during the May 2011 survey. Water profile records were obtained from two stations inside the expansion areas, one of which was also sampled for water physical analysis. Sediment and benthic infaunal samples were collected from five stations including inside and outside the expansion areas and inside the ODMDS. Epifaunal trawls were performed during the day and after dark at each of four stations, including two stations inside the expansion areas.

Sediment physical results indicate an homogeneous seafloor composition, with analogous results inside and outside the expansion areas and inside the ODMDS. Sediment chemical results suggest that the ODMDS has greater concentrations of certain metals, organochlorine pesticides, PAHs, and PCBs versus the expansion areas and the surrounding area. However, the chemical results are intended primarily as a baseline for future monitoring and are not relied upon for choosing a preferred expansion area. No consistent spatial pattern was observed in tissue chemistry and, like sediment chemistry, the results are intended primarily as baseline data.

Some faunal parameters did not show significant differences between sites. No nonindigenous species were identified from faunal samples. Although the mean total infaunal density found inside the expansion areas was greater than that found outside these areas, the differences were not considered significant by Barry Vittor & Associates (2011) and could be explained by the high variability of density between stations. The ODMDS had a much greater mean total infaunal density than inside or outside the expansion areas, although the sample size inside the ODMDS was too small to ascertain the significance of these results. Mean infaunal diversity and evenness index values and mean infaunal taxa richness were similar in relation to the expansion areas. Infaunal biomass was similar inside versus outside the expansion areas. Managed taxa densities were very similar inside versus outside the expansion areas.

Some parameters appeared to differ significantly in relation to the expansion areas. Greater values were identified outside the expansion areas compared to inside the expansion areas and involved total epifaunal biomass, mean epifaunal density, mean epifaunal Shannon diversity index values, and total abundant epifaunal taxa density. The following summary provides a tabulated version of the above-discussed parametric comparisons in relation to the expansion areas and is not intended to be an aide in decision-making.

Rapid Comparison Table of Greatly Condensed Results of May 2011 Survey			
Parameter Results	**Inside ODMDS**	**Inside Expansion Areas**	**Outside Expansion Areas**
Water Profile	N/A (only sampled inside expansion areas)		
Water: Physical	N/A (only sampled inside expansion areas)		
Sediment: Physical (% by weight)	0.0 Gravel 64.3 Sand 35.7 Silt & Clay	0.0–0.0 Gravel 55.7–64.9 Sand 35.1–44.3 Silt & Clay	0.0–0.0 Gravel 58.3–63.6 Sand 36.4–41.7 Silt & Clay
Sediment: Metals, TOC, Organotins	All 10 metals detected	All 10 metals detected	All 10 metals detected
Sediment: Pesticides	4 pesticides detected Exceeded TEL, ERL, and AET in 1	No analytes detected	No analytes detected
Sediment: PAHs	All 18 PAHs detected Exceeded TEL for 4 PAHs	No analytes detected	No analytes detected
Sediment: PCBs	14 PCB congeners detected	No analytes detected	No analytes detected
Infauna: Mean Total Biomass (g)	0.2285	0.2084	0.1124
Infauna: Mean Density (individuals/m^2)	3,266.7	1,700.0	1,054.2
Infauna: Mean Shannon Diversity	3.89	3.53	3.50
Epifauna: Total Biomass (kg/1,000 m^2)	N/A	0.44	0.76
Epifauna: Mean Density (individuals/1,000 m^2)	N/A	42.18	58.78
Epifauna: Mean Shannon Diversity	N/A	1.69	1.81
Epifauna: Total Abundant Taxa Density (individuals/1,000 m^2)	N/A	36.98	54.85
Epifauna: Managed Taxa Density (individuals/1,000 m^2)	N/A	33.40	33.96
Nonindigenous Species Identified	0	0	0
Bioaccumulation	N/A	No significant differences observed	

7 REFERENCES

Abbott, R.T. 1962. *Sea Shells of the World: A Guide to the Better-Known Species*. Golden Press, New York, NY.

Adams, D.H. 2011. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Indian River Field Laboratory, Melbourne, FL. *Pers. Comm*.

Adams, D.H. and R.H. McMichael. 2007. Mercury in king mackerel, *Scomberomorus cavalla*, and Spanish mackerel, *S. maculatus*, from water of the south-eastern USA: regional and historical trends. *Marine and Freshwater Research* 58:187–193.

Adams, D.H., R.H. McMichael, and G.E. Henderson. 2003. *Mercury Levels in Marine and Estuarine Fishes of Florida, 1989–2001*. Florida Marine Research Institute Technical Report TR-9, FWC, St. Petersburg, FL.

Adams, D.H. and G.V. Onorato. 2005. Mercury concentrations in red drum, *Scianops ocellatus*, from estuarine and offshore waters of Florida. *Marine Pollution Bulletin* 50:291–300.

Alvarez, M.C., C.A. Murphy, K.A. Rose, I.D. McCarthy, and L.A. Fuiman. 2006. Maternal body burdens of methylmercury impair survival skills of offspring in Atlantic croaker (*Micropogonias undulatus*). *Aquatic Toxicology* 80:329–337.

ANAMAR Environmental Consulting, Inc. 2010. *Port Everglades ODMDS Expansion Survey, Port Everglades, Florida*. Report submitted to USACE, Jacksonville District, Jacksonville, FL.

Arnot, J.A. and F.A.P.C. Gobas. 2006. A review of bioconcentration factor (BCF) and bioaccumulation factor (BAF) assessments for organic chemicals in aquatic organisms. *Environmental Review* 14(2006):257–297.

Baker, P., S.M. Baker, and J. Fajans. 2004. *Nonindigenous Marine Species in the Greater Tampa Bay Ecosystem: Literature Review and Field Survey of Tampa Bay for Nonindigenous Marine and Estuarine Species*. Report submitted to the Tampa Bay Estuary Program, Tampa, FL.

Barry A. Vittor & Associates, Inc. 1985. *Benthic Macroinfaunal Analysis of the Port Everglades and Palm Beach, Florida, Ocean Dredged Material Disposal Site Surveys, November 1984*. Submitted to EPA Region 4, Atlanta, GA, under contract with Battelle, Washington, D.C.

Barry A. Vittor & Associates, Inc. 2004. *Draft Work/Quality Assurance Project Plan for Benthic Macroinvertebrate and Sediment Sample Analysis and Data Interpretation for Ocean Dredged Material Disposal Sites*. Submitted to EPA Region 4, Atlanta, GA.

Barry A. Vittor & Associates, Inc. 2011. *Port Everglades Harbor ODMDS Expansion Designation Survey, Benthic Community Assessment*. Submitted to ANAMAR Environmental Consulting, Inc., Gainesville, FL.

Bureau International des Poids et Mesures. 2006. *The International System of Units (SI)*. Organisation Intergouvernementale de la Convention du Mètre, Paris, France.

Bigelow, H.B. and W.C. Schroeder. 1953. *Sawfishes, guitarfishes, skates, and rays. Fishes of the Western North Atlantic. Part 1. Memoir of the Sears Foundation for Marine Research*. Yale University, New Haven, CT.

Bridges, T.S. and K. von Stackelberg. 2003. *A Management Guide for a Tiered Risk Assessment Procedure for Evaluating Bioaccumulation Data Collected during Regulatory Evaluations of Dredged Material*. USACE Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS.

Buchman, M.F. 2008. *NOAA Screening Quick Reference Tables*. NOAA, OR&R Report 08-1, Office of Response and Restoration Division, Seattle, WA.

Cairns, S.D., D.R. Calder, A. Brinckmann-Voss, C.B. Castro, D.G. Fautin, P.R. Pugh, C.E. Mills, W.C. Jaap, M.N. Arai, S.H.D. Haddock, and D.M. Opresko. 2002. *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Cnidaria and Ctenophora*. American Fisheries Society, Special Publication 28, Bethesda, MD.

Camp, D.K., W.G. Lyons, and T.H. Perkins. 1998. *Checklists of Selected Shallow-water Marine Invertebrates of Florida*. FDEP, Florida Marine Research Institute Technical Report TR-3, St. Petersburg, FL.

Cearley, J.E. and R.L. Coleman. 1974. Cadmium toxicity and bioconcentration in largemouth bass and bluegill. *Bulletin of Environmental Contamination and Toxicology* 12(1):146–151.

Continental Shelf Associates, Inc. 1986. *Final Report, Video, Still Camera, and Side-scan Sonar Survey of the Seafloor within and downcurrent of a Tentative Alternative Ocean Dredged Material Disposal Site off Port Everglades, Florida*. Prepared for Battelle Ocean Sciences, submitted to EPA, Office of Marine and Estuarine Protection, Washington, D.C.

Cuvin-Aralar, M.L.A. and R.W. Furness. 1991. Mercury and selenium interaction: A review. *Ecotoxicology and Environmental Safety* 21:348–364.

Elton, C.S. 1958. *The Ecology of Invasions by Animals and Plants*. Methuen and Co., London.

Emery, K.O. and E. Uchupi. 1972. *Western North Atlantic Ocean: Topography, Rocks, Structure, Water, Life, and Sediments*. The American Association of Petroleum Geologists, Tulsa, OK.

eRegulations. 2011. *Florida Saltwater Fishing Regulations* [web page]. Accessed 08/19/11 online at http://www.eregulations.com/florida/fishing/saltwater/management-of-florida-marine-fishes-in-state-and-federal-waters/.

Fattorini, D., A. Notti, and F. Regoli. 2006. Characterization of arsenic content in marine organisms from temperate, tropical, and polar environments. *Chemistry and Ecology* 22(5):405–414.

Fenna, D. 2002. *A Dictionary of Weights, Measures and Units*. Oxford University Press, New York, NY.

Florida Department of Environmental Protection. 2008. *Standard Operating Procedures for Field Activities. Quality Manual*. Florida Department of Environmental Protection, Division of Law Enforcement, Bureau of Emergency Response, Tallahassee, FL.

Florida Fish and Wildlife Conservation Commission (FWC). 2011. *Commercial Saltwater Regulations, July 2011* [online PDF]. Assessed 08/19/11 online at: http://myfwc.com/media/1419879/ComRegs2011.pdf.

Freeman, B.L. and L.A. Walford. 1976. *Angler's Guide to the United States Atlantic Coast: Fish, Fishing Grounds & Fishing Facilities. Section VII, Altamaha Sound, Georgia to Fort Pierce, Florida*. U.S. Department of Commerce, NOAA, NMFS, Washington, D.C.

Germano & Associates, Inc. 2006. *Rapid Seafloor Reconnaissance and Assessment of Southeast Florida Ocean Dredged Material Disposal Sites Utilizing Sediment Profile Imaging. May 2006 Post-Disposal SPI Mapping at the Port Everglades Harbor ODMDS*. Submitted to EPA, Region 4, Water Management Division, Coastal Section, Atlanta, GA.

Gilmore, R.G. 2011. Estuarine, Coastal and Ocean Science, Inc., Vero Beach, FL. *Pers. Comm*.

Gregg, L. 2011. Division of Marine Fisheries, Florida Fish and Wildlife Conservation Commission, Tallahassee, FL. *Pers. Comm*.

Hine, A.C. 1997. Structural and paleoceanographic evolution of the margins of the Florida Platform. Pp. 169–194. In: Randasso, A.F. and D.S. Jones (eds.) *The Geology of Florida*. University Press of Florida, Gainesville, FL.

Holcolme, G.W., D.A. Benoit, and E.N. Leonard. 1976. Long-term effects of lead exposure on three generations of brook trout (*Salvelinus fontinalis*). *Journal of the Fisheries Research Board of Canada* 33:1731–1741.

Iannuzzi, T.J., T.N. Armstrong, J.B. Thelen, D.F. Ludwig, and C.E. Firstenberg. 2004. Chemical contamination of aquatic organisms from an urbanized river in the New York/New Jersey harbor estuary. *Human and Ecological Risk Assessment* 10:389–413.

Iwamoto, T. 2002. Phycidae. Phycid hakes. Pp. 1,005–1,014. In: Carpenter, K.E. (ed.), *FAO Species Identification Guide for Fishery Purposes: The Living Marine Resources of the Western Central Atlantic. Vol. 2: Bony fishes part 1 (Acipenseridae to Grammatidae).* FAO, Rome, Italy.

Johnson-Restrepo, B., K. Kannan, R. Addink, and D.H. Adams. 2005. Polybrominated diphenyl ethers and polychlorinated biphenyls in a marine foodweb of coastal Florida. *Environmental Science & Technology* 39(21):8,243–8,250.

Jones, R.P., R.N. Millward, R.A. Karn, and A.H. Harrison. 2006. Microscale analytical methods for the quantitative detection of PCBs and PAHs in small tissue masses. *Chemosphere* 62:1,795–1,805.

Klein-MacPhee, G. 2002. Cods. Family Gadidae. Pp. 223–261. In: Collette, B.B. and G. Klein-MacPhee (eds.), *Bigelow and Schroeder's Fishes of the Gulf of Maine*. Smithsonian Institution Press, Washington, D.C.

Krone, C.A., D.W. Brown, D.G. Burrows, R.G. Bogar, S. Chan, and U. Varanasi. 1989. A method for analysis of butyltin species and measurements of butyltins in sediment and English sole livers from Puget Sound. *Marine Environmental Research* 27(1):1–18.

Lachner, E.A., C.R. Robins, and W.R. Courtenay. 1970. *Exotic Fishes and Other Aquatic Organisms Introduced into North America*. Smithsonian Contributions to Zoology Number 59, Smithsonian Institution Press, Washington, D.C.

Latif, M.A., R.A. Bodaly, T.A. Johnston, R.J.P. Fudge. 2001. Effects of environmental and maternally derived methylmercury on the embryonic and larval stages of walleye (*Stizostedion vitreum*). *Environmental Pollution* 111:139–148.

Lie, U. and M.M. Pamatmat. 1965. Digging characteristics and sampling efficiency of the 0.1 m^2 van Veen grab. *Limnology and Oceanography* 10(3):379–384.

Lotufo, G. 2011. USACE, Engineer Research and Development Center, Louisiana State University, Department of Oceanography & Coastal Sciences, Baton Rouge, LA. *Pers. Comm.*

Maptech. 2007. *Chartkit. Florida East Coast and the Keys. Region 7. 14th Edition*. Maptech, Inc., Amesbury, MA.

McArthur, C.J. 2011. *Survey Report. Port Everglades Harbor ODMDS Expansion Designation Survey*. EPA, Region 4, Wetlands, Coastal and Oceans Branch, Atlanta, GA.

McEachran, J.D. and M.R. de Carvalho. 2002. Narcinidae. Numbfishes (AFS: electric rays). Pp. 518–523. In: Carpenter, K.E. (ed.), *FAO Species Identification Guide for Fishery Purposes: The Living Marine Resources of the Western Central Atlantic. Vol. 1: Introduction, Molluscs, Crustaceans, Hagfishes, Sharks, Batoid Fishes and Chimaeras.* FAO, Rome, Italy.

Millward, R. Jones, R. Karn, and A. Harrison. 2007. *A Microscale Approach for the Quantitative Detection of PCBs and PAHs in Small Tissue Masses*. DOER Technical Note TN-DOER-T9, USACE, Engineer Research and Development Center, Vicksburg, MS.

Mount, D.R. , A.K. Barth, and T.D. Garrison. 1994. Dietary and waterborne exposure of rainbow trout (*Oncorhynchus mykiss)* to copper, cadmium, lead and zinc using a live diet. *Environmental Toxicology and Chemistry* 13(12): 2031–2041.

Nakamura, I. 1985. *FAO Species Catalogue Vol. 5, Billfishes of the World. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes and swordfishes known to date*. United Nations Development Programme, Food and Agriculture Organization of the United Nations, Rome, Italy.

National Oceanic and Atmospheric Administration. 1989. *A Summary of Data on Tissue Contamination from the First Three Years (1986–1988) of the Mussel Watch Project*. NOAA Technical Memorandum NOS OMA 49, Rockville, MD.

National Oceanic and Atmospheric Administration. 2007. *Magnuson-Stevens Fishery Conservation and Management Act as Ammended Through January 12, 2007*. NOAA, National Marine Fisheries Service, U.S. Government Printing Office, Washington, D.C.

Nelson, J.S. 2006. *Fishes of the World*. *Fourth Edition*. John Wiley & Sons, Inc., Hoboken, NJ.

Nelson, J.S., E.J. Crossman, H. Espinosa-Pérez, L.T. Findley, C.R. Gilbert, R.N. Lean, and J.D. Williams. 2004. *Common and Scientific Names of Fishes from the United States, Canada, and Mexico. Sixth Edition*. American Fisheries Society Special Publication 29, Bethesda, MD.

Orn, S., P.L. Andersson, L. Forlin, M. Tysklind, and L. Norrgren. 1998. The impact on reproduction of an orally administered mixture of selected PCBs in zebrafish (*Danio rerio). Archives of Environmental Contamination and Toxicology* 35(1):52–57.

Parker, R.O. and R.W. Mays. 1998. *Southeastern U.S. Deepwater Reef Fish Assemblages, Habitat Characteristics, Catches, and Life History Summaries.* NOAA Technical Report NMFS-138, U.S. Department of Commerce, NOAA, NMFS, Seattle, WA.

Pequegnat, W.E., B.J. Gallaway, and T.D. Wright. 1990. *Revised Procedural Guide for Designation Surveys of Ocean Dredged Material Disposal Sites*. Department of the Army, Waterways Experiment Station, U.S. Army Corps of Engineers, Vicksburg, MS.

Pielou, E.C. 1966. The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology* 13:131–144.

Plumb, R.H. 1981. *Procedure for Handling and Chemical Analysis of Sediment and Water Samples*. Prepared by Great Lakes Laboratory, State University College at Buffalo (Buffalo, NY) for EPA and USACE Technical Committee on Criteria for Dredged and Fill Material, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Randall, J.E. 1967. Food habits of reef fishes of the West Indies. *Studies in Tropical Oceanography* 5:665–847.

Rainbow, P.S. 2006. Trace metal bioaccumulation: Models, metabolic availability and toxicity. *Environment International* 33(2007):576–582.

Rider, S.J. and D.H. Adams. 2000. Mercury concentrations in spotted seatrout (*Cynoscion nebulosus*) from northwest Florida. *Gulf of Mexico Science* 18(2):97–103.

Robins, C.R. and G.C. Ray. 1986. *A Field Guide to Atlantic Coast Fishes of North America*. Houghton Mifflin Co., New York, NY.

Robichaud, D.A. and C. Frail. 2006. Development of Jonah crab, *Cancer borealis*, and rock crab, *Cancer irroratus*, fisheries in the Bay of Fundy (LFAs 35-38) and off southwest Nova Scotia (LFA 34): from exploratory to commercial status (1995-2004). *Canadian Manuscript Report of Fisheries and Aquatic Sciences* 2775:iii–48.

Science Applications International Corporation. 1986. *Ocean Dumping Site Designation Delegation Handbook for Dredged Material*. Submitted to EPA, Office of Marine and Estuarine Protection, Washington, DC.

Slapcinsky, J.H. 2011. Division of Malacology, Florida Museum of Natural History, Gainesville, FL. *Pers. Comm*.

Smith-Vaniz, W.F. 2002. Jacks and scads (bumpers, pompanos, leatherjackets, amberjacks, pilotfishes, rudderfishes). Pp. 1,426–1,468. In: Carpenter, K.E. (ed.), *FAO Species Identification Guide for Fishery Purposes: The Living Marine Resources of the Western Central Atlantic. Vol. 3: Bony Fishes Part 2 (Opistognathidae to Molidae), Sea Turtles and Marine Mammals*. FAO, Rome, Italy.

Taylor Engineering, Inc. 2010. *Evaluation of Dredged Material Behavior at the Port Everglades Harbor Federal Project Ocean Dredged Material Disposal Site, Broward County, FL* [Updated November 2010]. Report submitted to USACE, Jacksonville District, Jacksonville, FL.

The Weather Channel. 2011. *Weather.com* [website]. Accessed 05/18/11 online at: http://www.weather.com/outlook/travel/vacationplanner/monthly/USFL0149?month=-1.

Turgeon, D.D., J.F. Quinn, A.E. Bogan, E.V. Coan, F.G. Hochberg, W.G. Lyons, P.M. Mikkelsen, R.J. Neves, C.F.E. Roper, G. Rosenberg, B. Roth, A. Scheltema, F.G. Thompson, M. Vecchione, and J.D. Williams. 1998. *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada. Mollusks*. *Second Edition*. American Fisheries Society Special Publication 26, Bethesda, MD.

Türkman, G. and N. Kazanci. 2010. Applications of various diversity indices to benthic macroinvertebrate assemblages in streams of a natural park in Turkey [conference proceedings]. *Balkan Water Observation and Information System*, May 25–29, 2010, Ohrid, Republic of Macedonia.

Ulanski, S. 2008. *The Gulf Stream: Tiny Plankton, Giant Bluefin, and the Amazing Story of the Powerful River in the Atlantic*. University of North Carolina Press, Chapel Hill, NC.

U.S. Congress, Office of Technology Assessment. 1992. *Harmful Non-indigenous Species in the United States*. U.S. Congress, Office of Technology Assessment, Washington, D.C.

U.S. Environmental Protection Agency. 1995. *QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations – Chemical Evaluations* [online PDF]. EPA-823-B-95-001. Accessed 08/10/10 online at: http://www.epa.gov/waterscience/cs/library/evaluationguide.pdf.

U.S. Environmental Protection Agency. 1999. *Sediment and Water Quality of Candidate Ocean Dredged Material Disposal Sites for Port Everglades and Palm Beach, Florida.* EPA, Region 4, Wetlands, Coastal and Water Quality Branch, Atlanta, GA for submission to USACE, Jacksonville District, Jacksonville, FL.

U.S. Environmental Protection Agency. 2000. *Sidescan Sonar Survey Results at the Candidate Ocean Dredged Material Disposal Sites for Port Everglades and Palm Beach, Florida.* EPA, Region 4, Wetlands, Coastal and NonPoint Source Branch, Atlanta, GA for submission to USACE, Jacksonville District, Jacksonville, FL.

U.S. Environmental Protection Agency. 2001. *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses* [online PDF]. EPA-823-B-01-002, EPA, Washington, D.C. Accessed 08/10/10 online at: http://www.epa.gov/waterscience/cs/library/collectionmanual.pdf.

U.S. Environmental Protection Agency. 2004. Essential Fish Habitat Assessment [Appendix I]. In: (EPA and USACE 2004) *Final Environmental Impact Statement (FEIS) for Designation of a Palm Beach Harbor Ocean Dredged Material Disposal Site and the Port Everglades Harbor Ocean Dredged Disposal Site*]. EPA, Region 4, Atlanta, GA, and USACE, Jacksonville District, Jacksonville, FL.

U.S. Environmental Protection Agency. 2006. *National Recommended Water Quality Criteria*. EPA, Offices of Water and Science and Technology, Washington, D.C.

U.S. Environmental Protection Agency. 2010. *Ocean Survey Vessel (OSV)* Bold [website]. Accessed 08/10/10 online at: http://water.epa.gov/type/oceb/assessmonitor/brochure.cfm.

U.S. Environmental Protection Agency. 2011. *EPA's Ocean Survey Vessel* Bold *2010 Annual Report, Monitoring and Assessing the Health of Our Oceans and Coastal Waters*. EPA, Oceans and Coastal Protection Division, Office of Wetlands, Oceans, and Watersheds, Washington, D.C.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1991. *Evaluation of Dredged Material Proposed for Ocean Disposal. Testing Manual* [Green Book]. EPA 503-8-91-001. EPA Region 4 and USACE, South Atlantic Division, Atlanta, GA.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 2004. *Final Environmental Impact Statement (FEIS) for Designation of a Palm Beach Harbor Ocean*

Dredged Material Disposal Site and the Port Everglades Harbor Ocean Dredged Disposal Site. EPA, Region 4, Atlanta, GA, and USACE, Jacksonville District, Jacksonville, FL.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 2008. *Southeast Regional Implementation Manual (SERIM) for Requirements and Procedures for Evaluation of the Ocean Disposal of Dredged Material in Southeastern U.S. Atlantic and Gulf Coast Waters*. EPA 904-B-08-001. EPA, Region 4 and USACE, South Atlantic Division, Atlanta, GA.

U.S. Food and Drug Administration. 2001. Chapter 9: Environmental Chemical Contaminants and Pesticides. In: U.S. Department of Health and Human Services (ed.), *Fish and Fishery Products Hazards and Controls Guidance, Third Edition* [online document]. Accessed 02/25/11 online at: http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/Seafood/FishandFisheriesProductsHazardsandControlsGuide/default.htm.

U.S. Food and Drug Administration. 2011. Chapter 9: Environmental Chemical Contaminants and Pesticides. In: U.S. Department of Health and Human Services (ed.), *Fish and Fishery Products Hazards and Controls Guidance, Fourth Edition* [online document]. Accessed 01/09/12 online at: http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/Seafood/FishandFisheriesProductsHazardsandControlsGuide/default.htm.

Williams, A.B., L.G. Abele, D.L. Felder, H.H. Hobbs, R.B. Manning, P.A. McLaughlin, and I.P. Farfante. 1989. *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Decapod Crustaceans.* American Fisheries Society Special Publication 17, Bethesda, MD.

Maps

Map 1. Port Everglades Harbor ODMDS Expansion Areas with May 2011 Sampling Locations

LEGEND

- CTD Profiles
- Benthic Infaunal Grabs
- Sediment Grabs
- Sampling Stations
- Trawls (Arrows Show Direction of Travel)
- Tissue Trawls (Arrows Show Direction of Travel)
- Proposed Expansion Area 1
- Proposed Expansion Area 2
- Existing ODMDS

N
W E
S

Nautical Miles
0 0.5 1

Proposed Expansion Area 1 4 sq. nmi

Proposed Expansion Area 2 4 sq. nmi

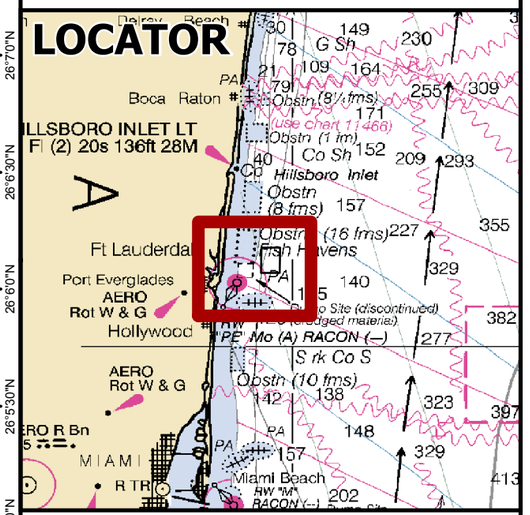
Existing Port Everglades Harbor ODMDS

PE11-1
PE11-2
PE11-3
PE11-4
PE11-5
PE11-6
PE11-7
PE11-8
PE11-9
PE11-10
PE11-11
PE11-12
PE11-13
PE11-14

13t1 Tissue
14t1 Tissue
10t3 Tissue
5t2 Tissue
6-EPI-A
6-EPI-B
7-EPI-A
7-EPI-B
8-EPI-A
8-EPI-B
9-EPI-A
9-EPI-B

Sunrise Blvd.
E. Las Olas Blvd.
Middle River
Port Everglades
COMMERCIAL ANCHORAGE 110.1, 110.186 (see note A)
PRECAUTIONARY AREA (see note E)
RESTRICTED AREA 334.580 (see note A)
TERRITORIAL SEA (see note X)
Obstn Fish Haven (auth min 40 ft)
Obstn Fish Haven (auth min 7 ft)
Obstn Fish Haven (auth min depth 30 ft)
Obstn (rep 60 ft)
Obstns PA
Dump Site (discontinued) (dredged material) (see note S) Depths from surveys of 1963 and 2000
Dump Site (dredged material) (see note S) Depths from survey of 1964
THREE NAUTICAL MILE LINE (see note A)
7980-W-14270
Cable Area (see note) (chart 11470)
Subm groin (10ft rep)
Subm buoys
Fl R 4s 5M "4"
Fl G 4s 5M "5"
RW "PE" Mo (A) RACON (—)

LOCATOR



ANAMAR Environmental Consulting, Inc.

This map and/or digital data is for planning purposes only and should not be used to determine the precise location of any feature. Data provided as-is.
Q:\GIS PROJECTS\2011 PORT EVERGLADES EXPANSION SURVEYS\PtEv_Sampling_May2011.mxd
Data sources: ANAMAR, USACE, USEPA, NOAA.

Figures

Figure 1. Photographs of Field Sampling Operations during the May 2011 Port Everglades Survey

Sieving Infaunal Samples
(*Photo courtesy of Elizabeth Walls, EPA*)

Infaunal Sample in Young-modified van Veen

Sediment Sample in Standard van Veen

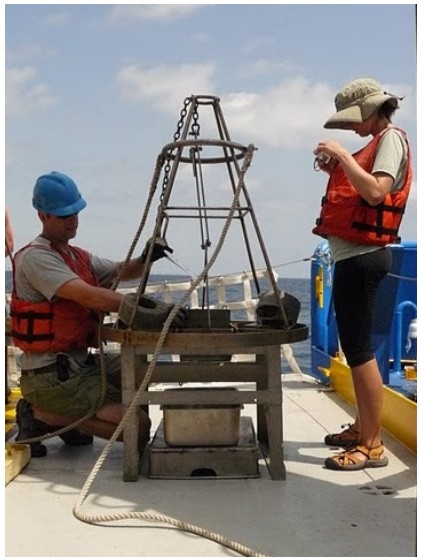
Decanting Water Sample from Niskin Bottle
(*Photo courtesy of Elizabeth Walls, EPA*)

Rough-sorting Trawl Sample on Stern Deck
(*Photo courtesy of Elizabeth Walls, EPA*)

Retrieving Trawl
(*Photo courtesy of Elizabeth Walls, EPA*)

ANAMAR Environmental Consulting, Inc.

Figure 1 (*continued*). Photographs of Field Sampling Operations during the May 2011 Port Everglades Survey



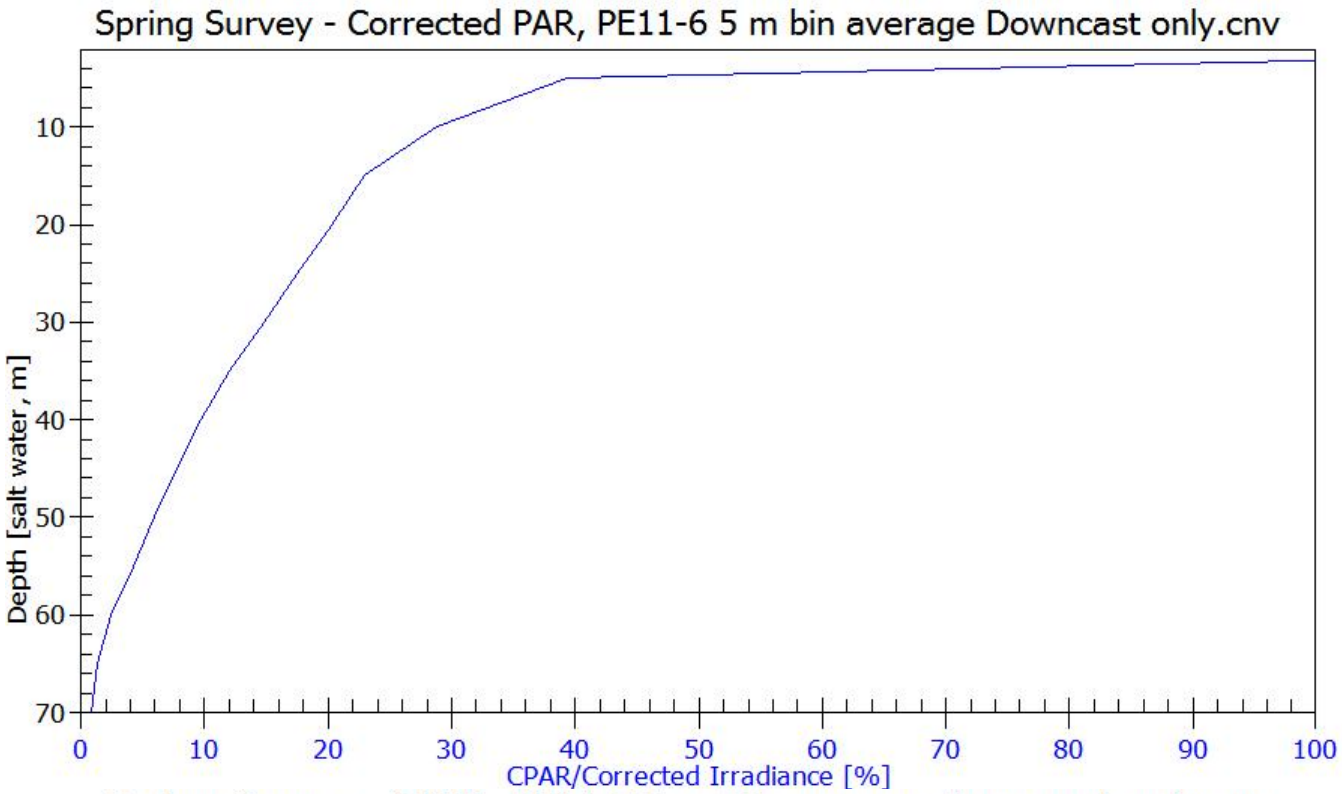
Emptying Infaunal Sample from Grab
(*Photo courtesy of Elizabeth Walls, EPA*)

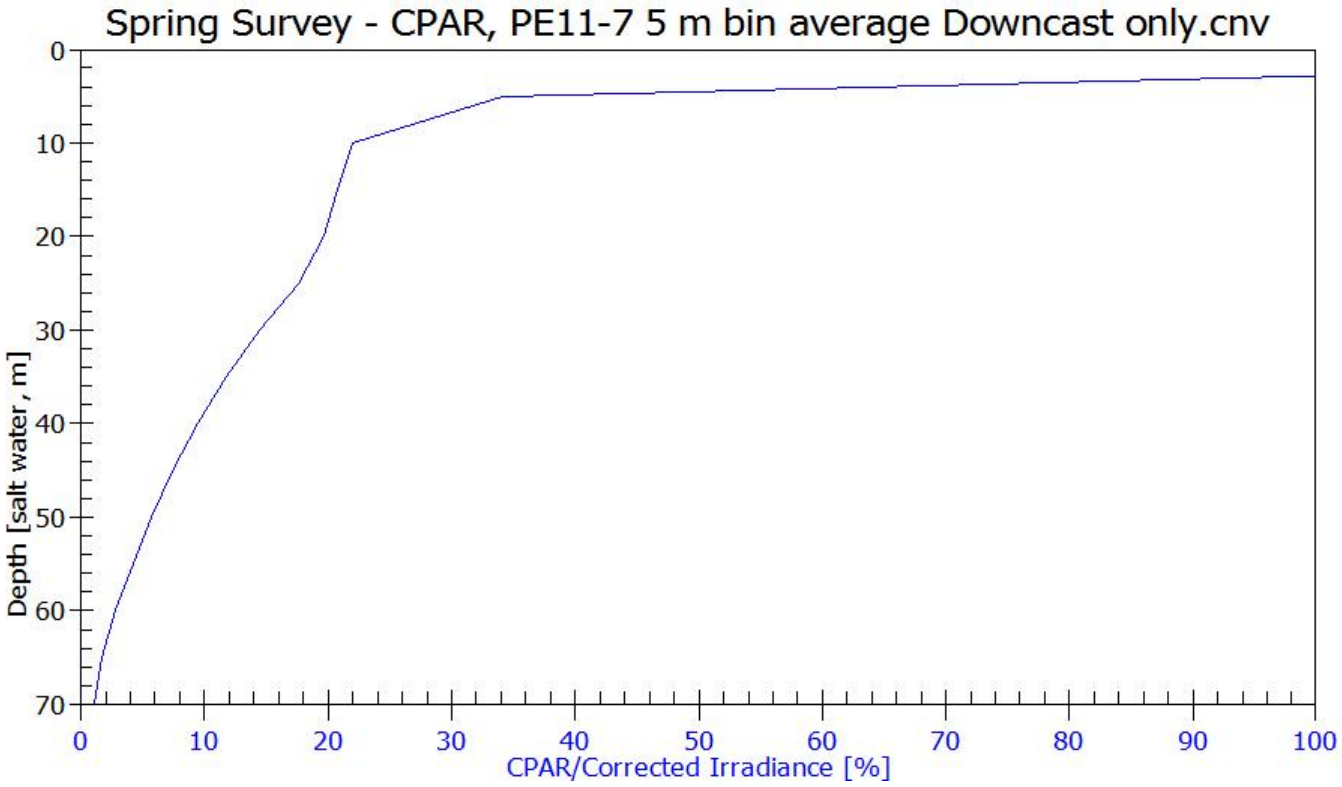
Extracting Tissue Samples
(*Photo courtesy of Elizabeth Walls, EPA*)

Sorting and Measuring Fishes
(*Photo courtesy of Elizabeth Walls, EPA*)

Most Field Participants of Survey
(*Photo courtesy of Elizabeth Walls, EPA*)

Figure 2. CTD Water Column Profiles Taken during the May 2011 Port Everglades Survey at Stations PE11-6 and PE11-7

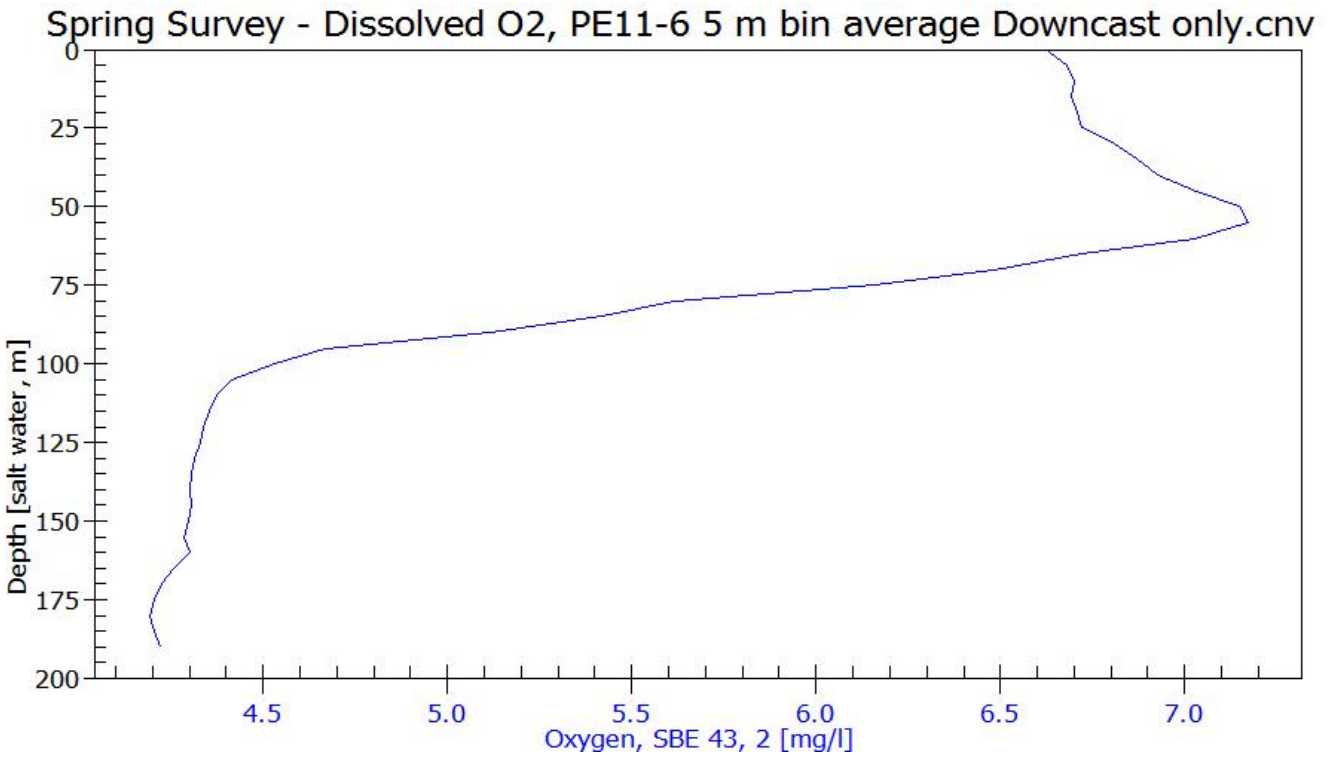




ANAMAR Environmental Consulting, Inc.

Figure 2

Figure 2 (*continued*). CTD Water Column Profiles Taken during the May 2011 Port Everglades Survey at Stations PE11-6 and PE11-7



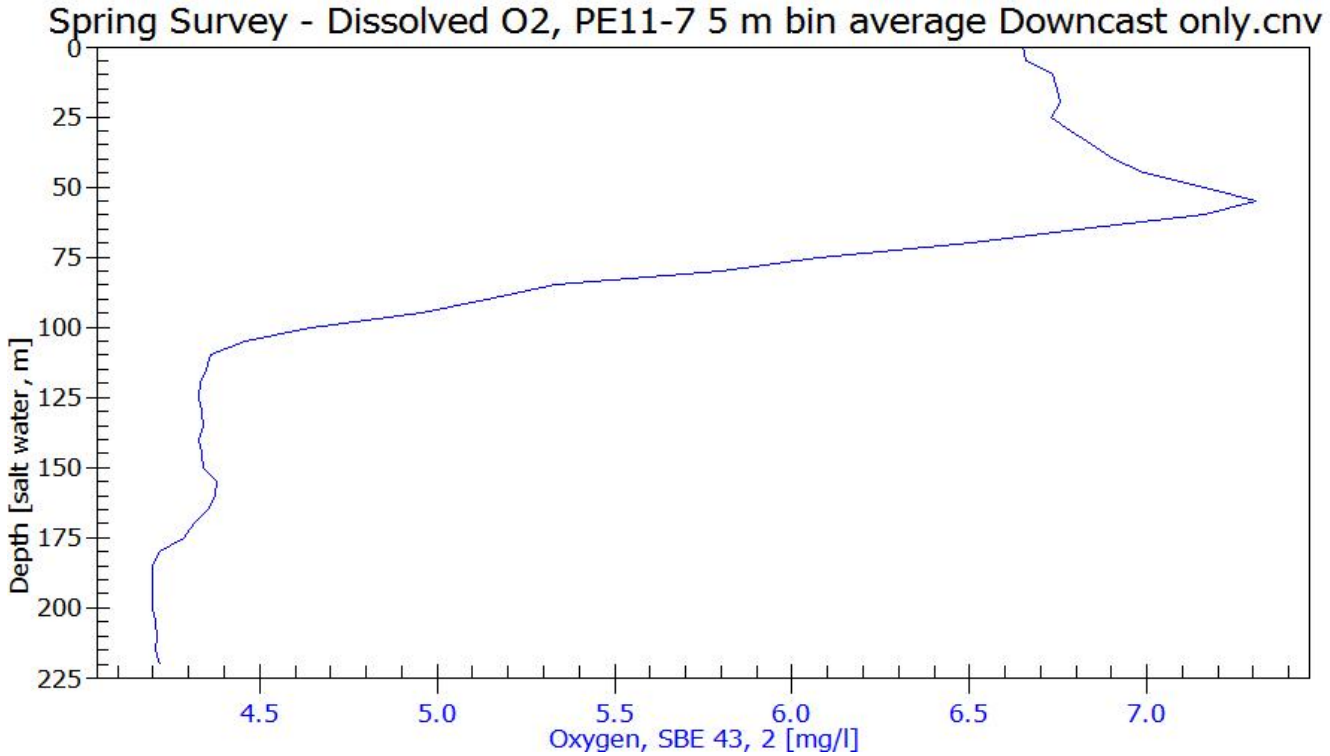
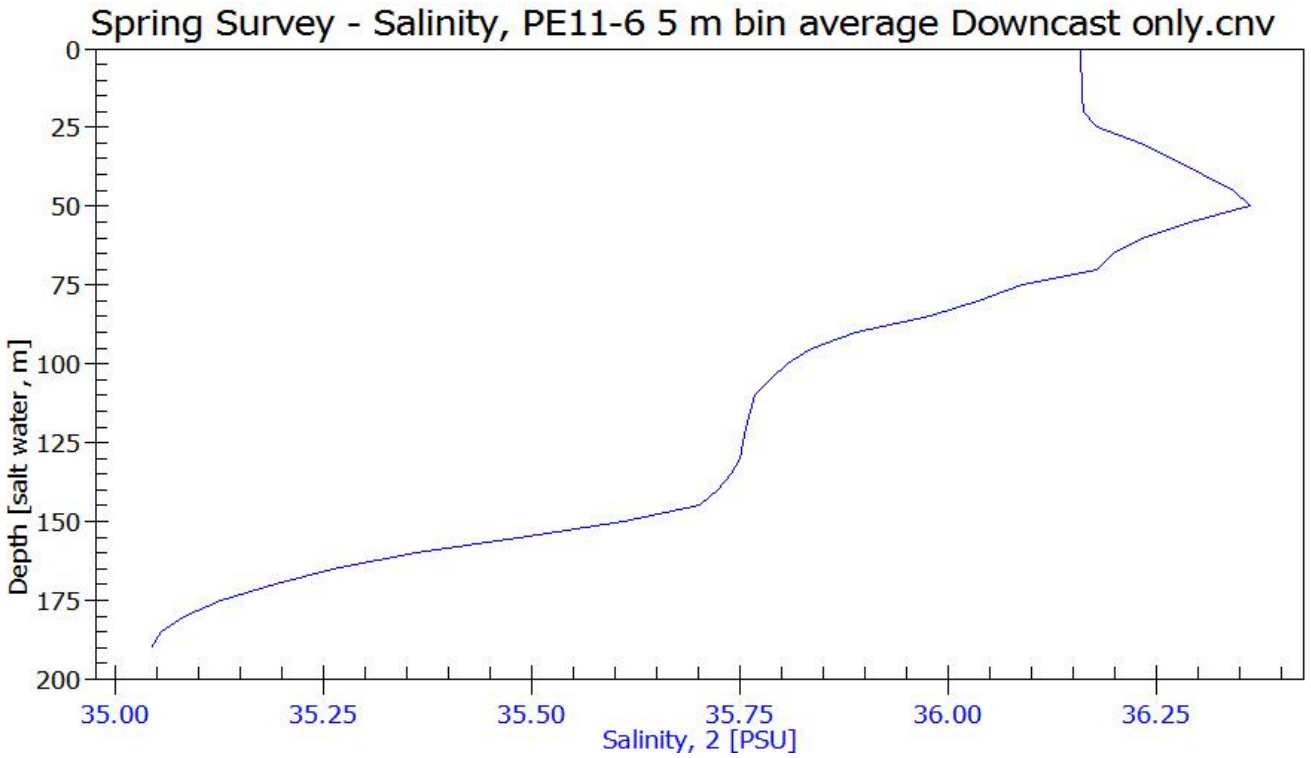


Figure 2 (*continued*). CTD Water Column Profiles Taken during the May 2011 Port Everglades Survey at Stations PE11-6 and PE11-7



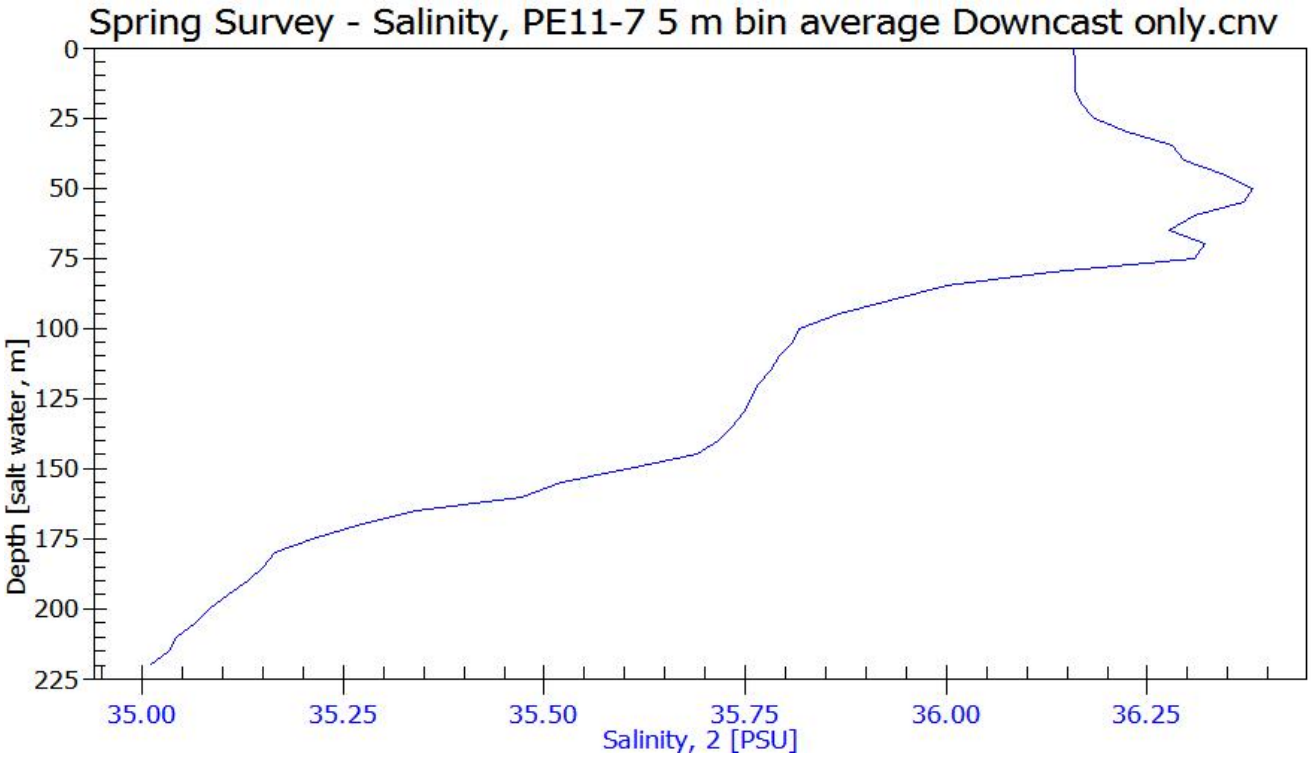
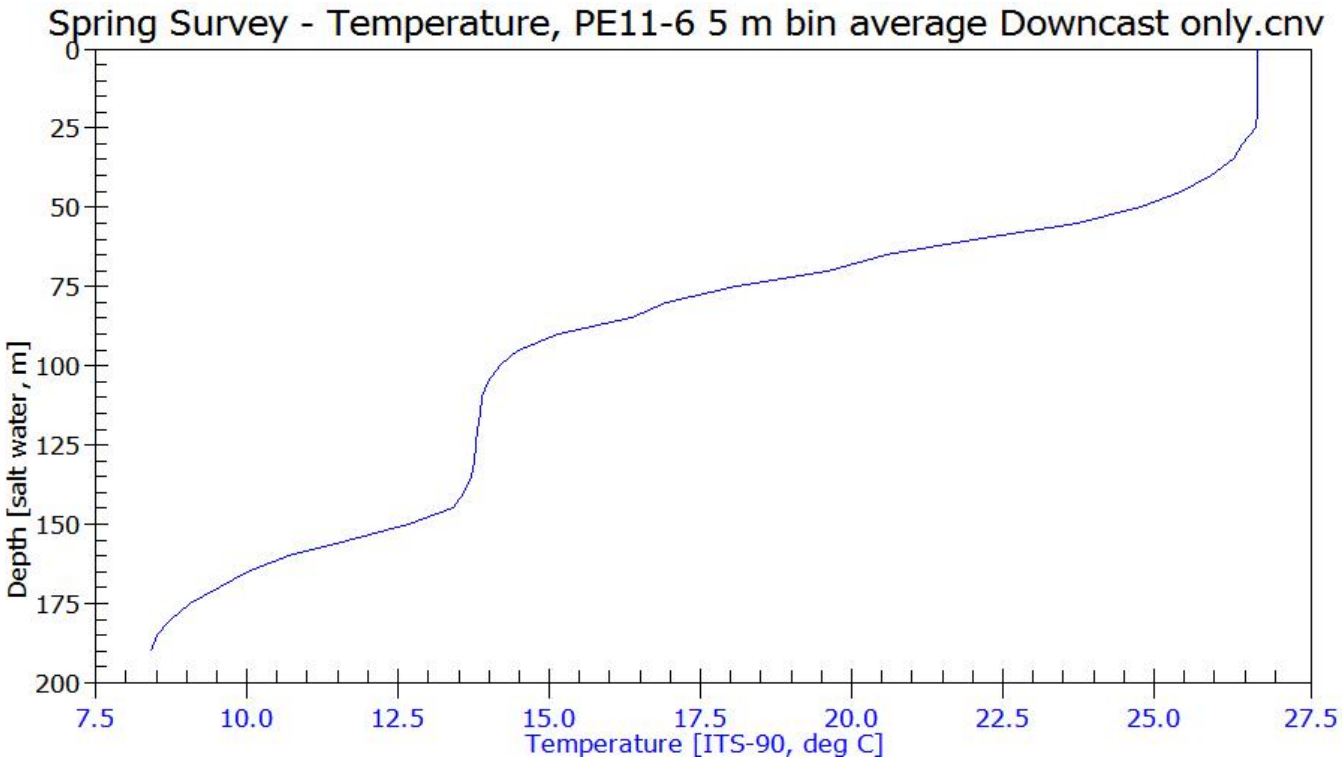


Figure 2 (*continued*). CTD Water Column Profiles Taken during the May 2011 Port Everglades Survey at Stations PE11-6 and PE11-7



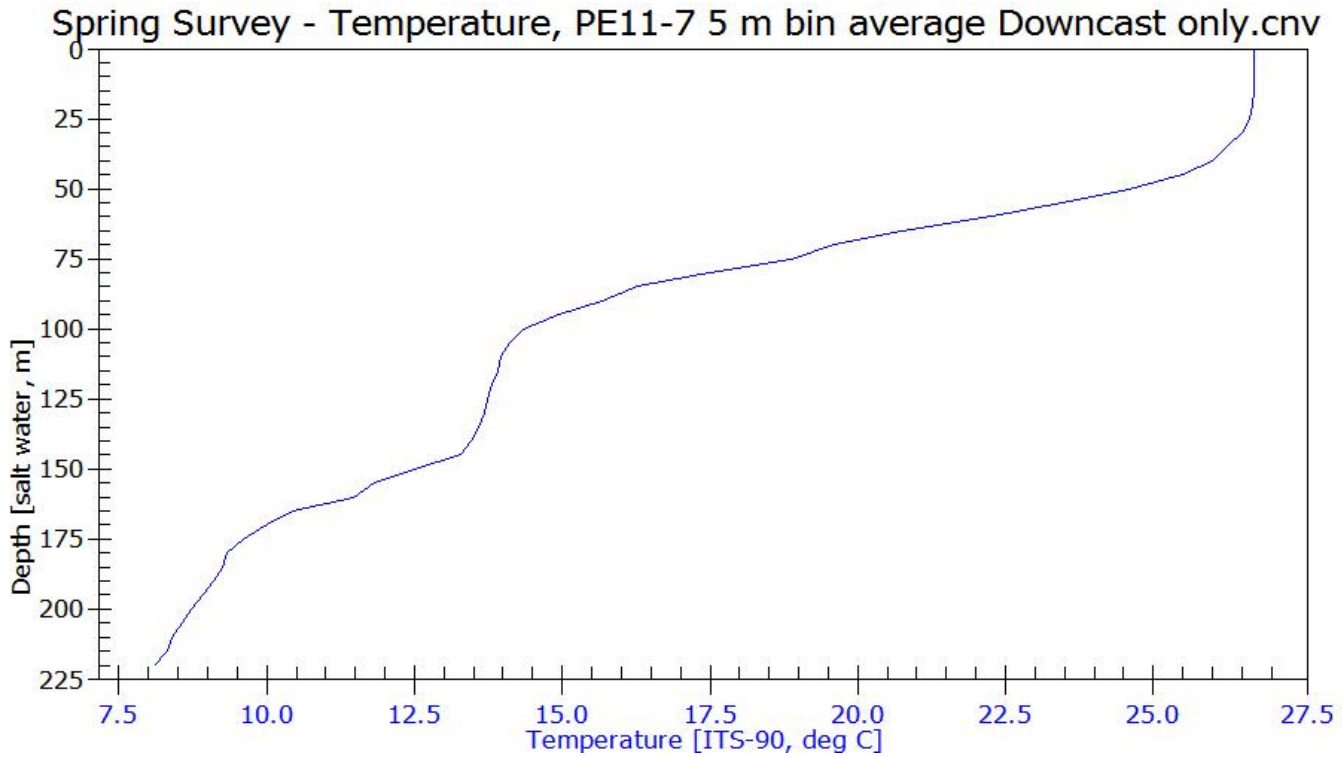
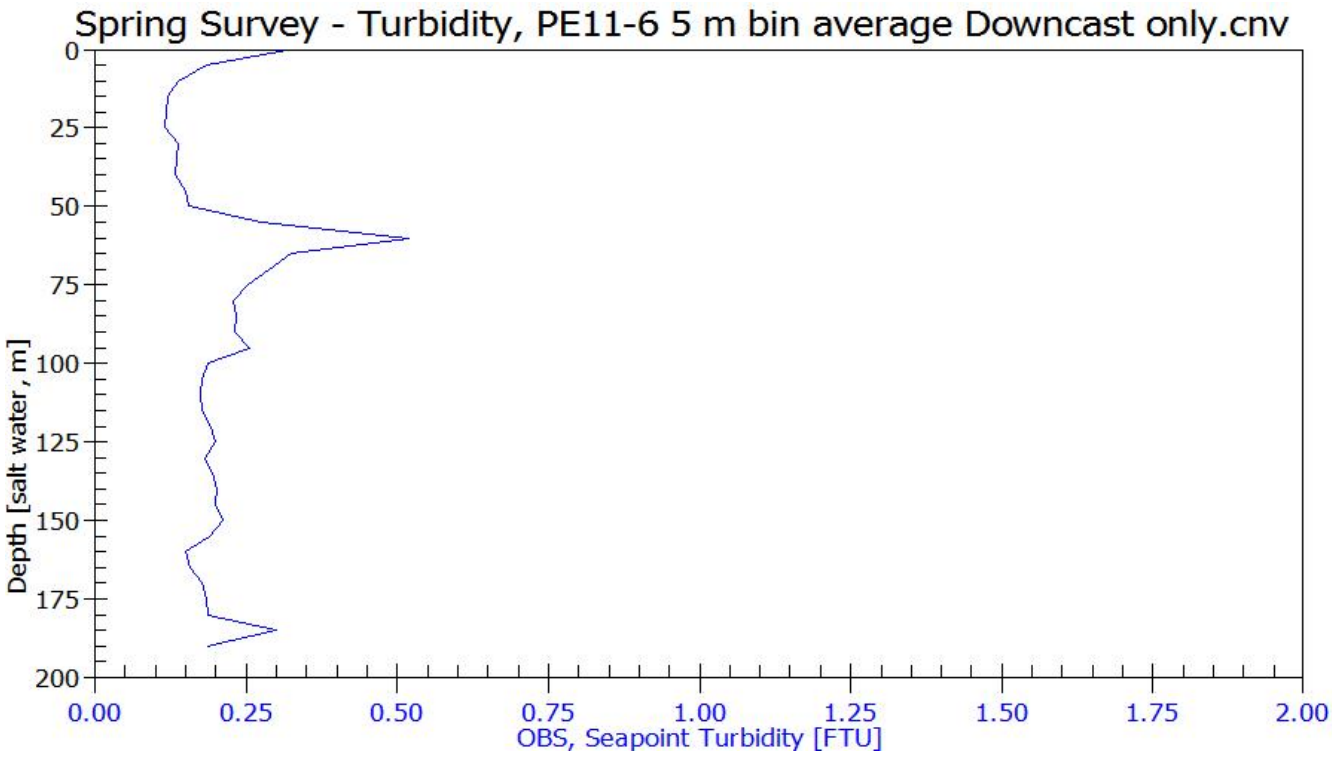


Figure 2 (*continued*). CTD Water Column Profiles Taken during the May 2011 Port Everglades Survey at Stations PE11-6 and PE11-7



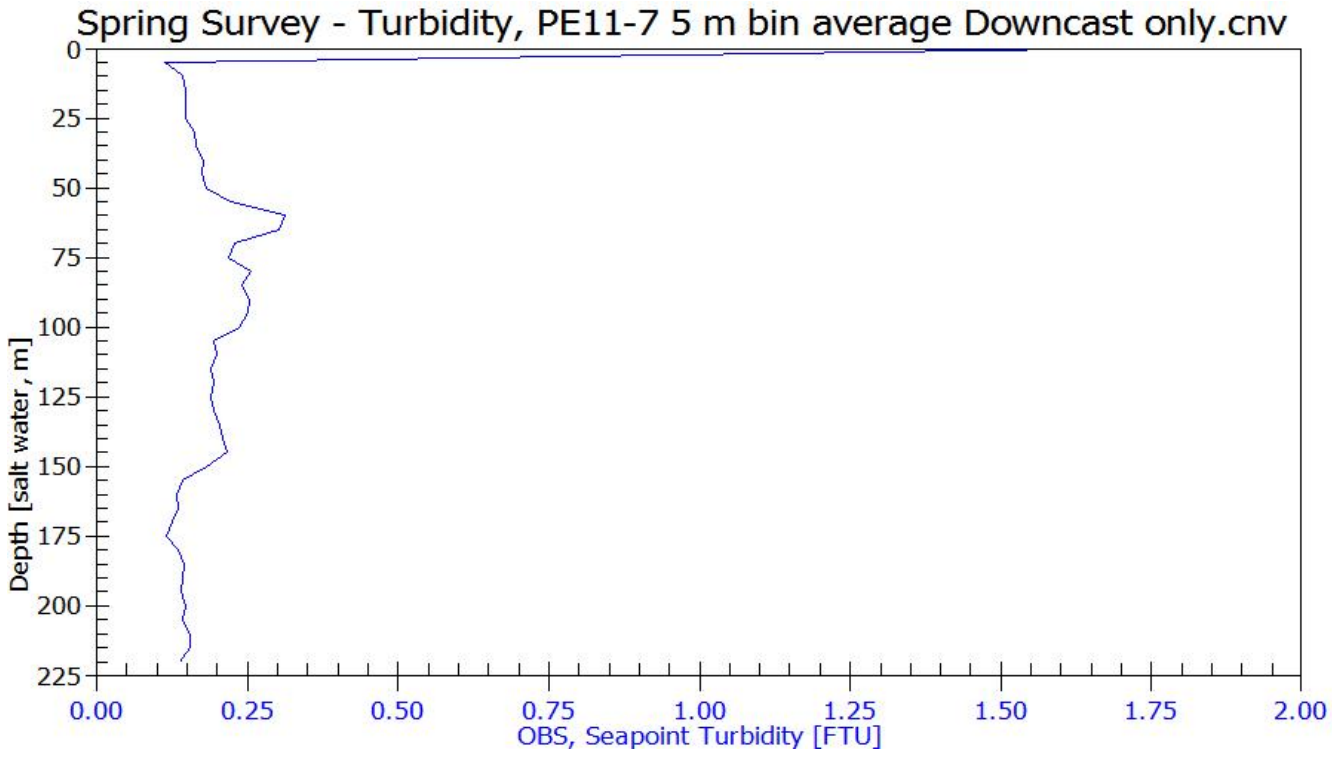
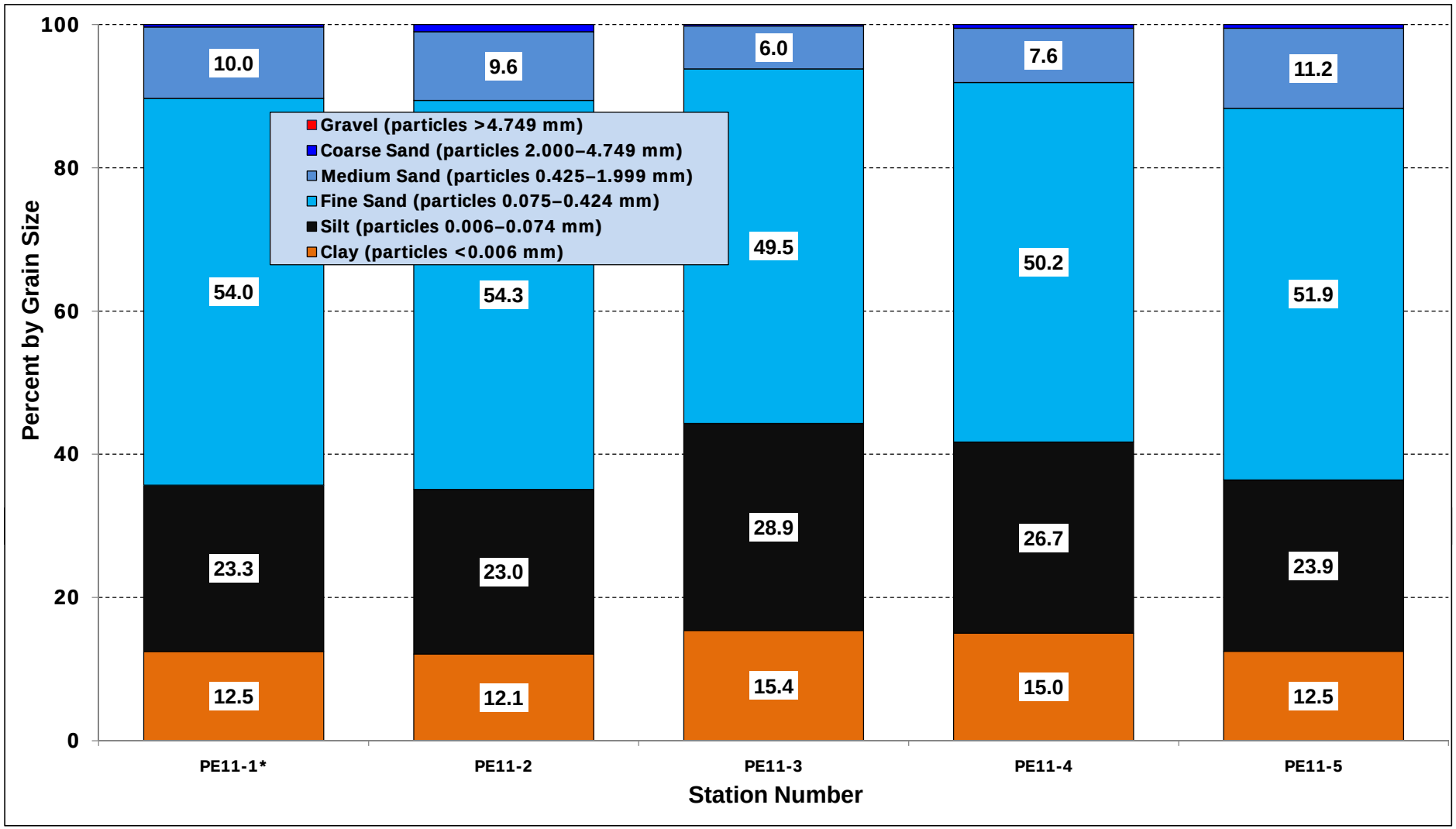


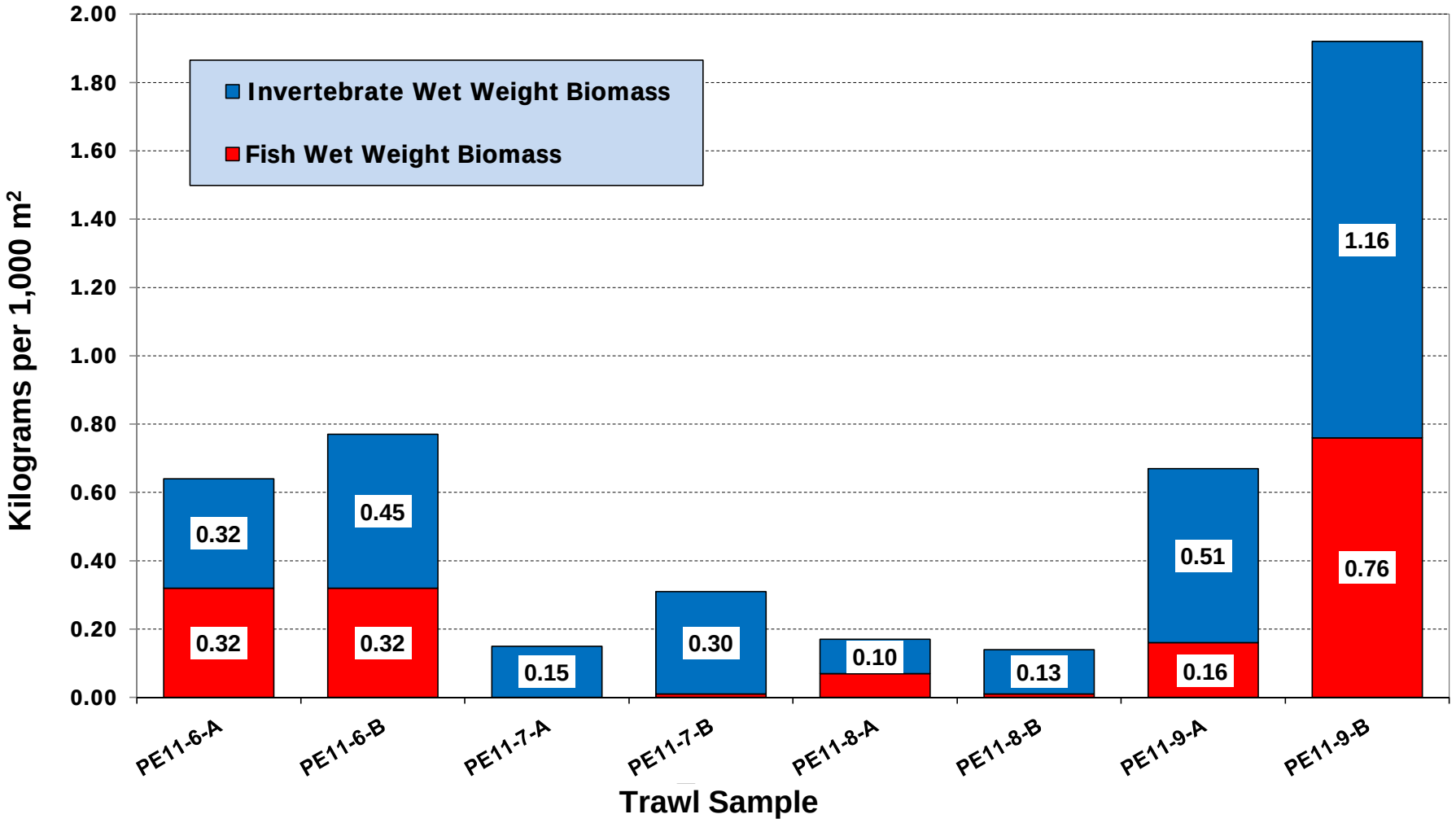
Figure 3. Sediment Grain Sizes per Station Collected during the May 2011 Port Everglades Survey



*Station PE11-1 grain size represented above consists of the mean of the sediment sample and the field split sample from that station.

Source: MACTEC Engineering and Consulting, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

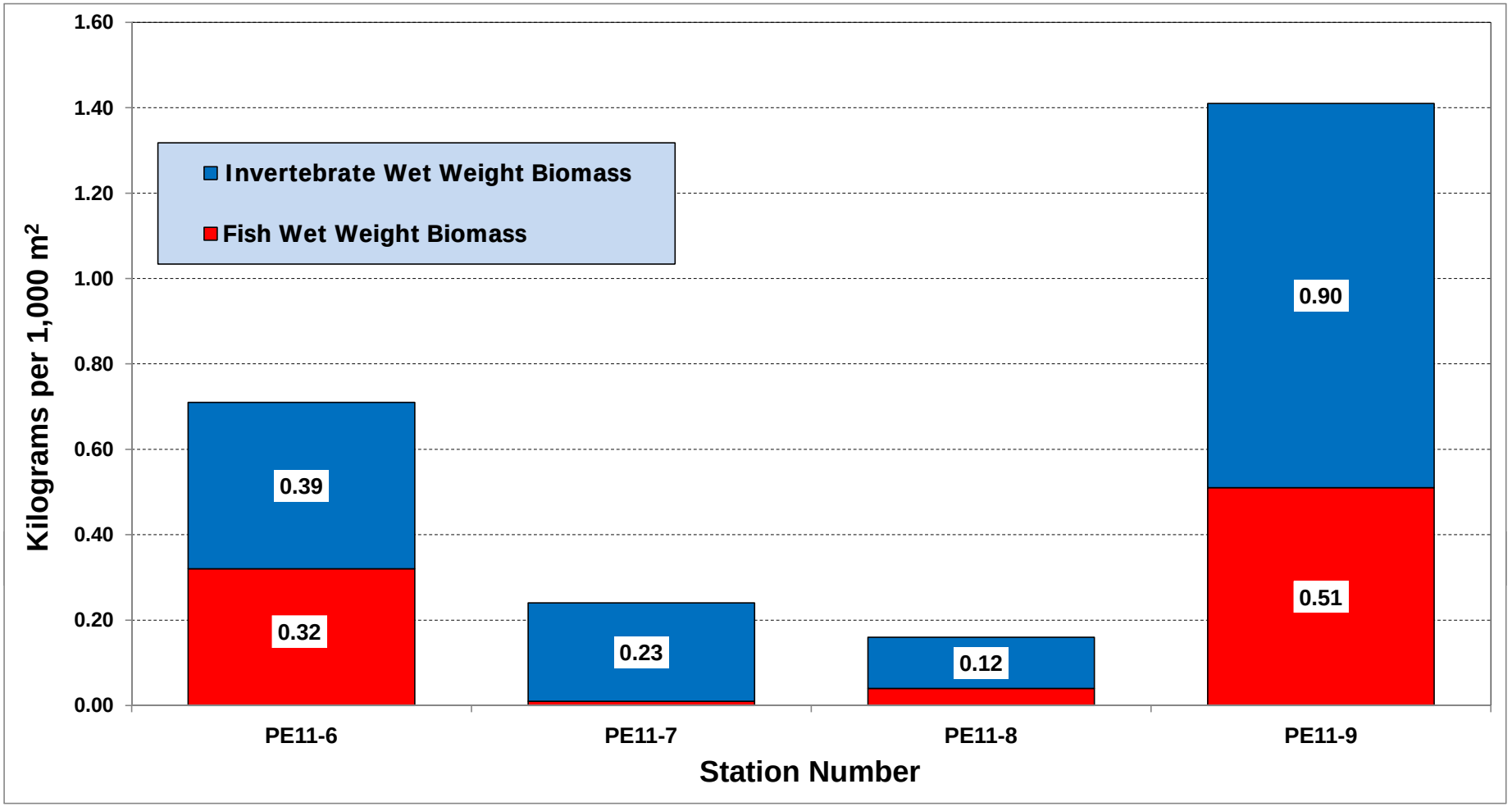
Figure 4. Invertebrate and Fish Biomass per Trawl Sample Captured during the May 2011 Port Everglades Survey



Trawl sample IDs are abbreviated to trawl sample (i.e, A, B) per station number (e.g., PE11-6).
Estimated surface area sampled = length of tow (nmi) x 1,852 (meters per nmi), product x 7.317 (width of trawl in meters).

Source: ANAMAR Environmental Consulting, Inc.

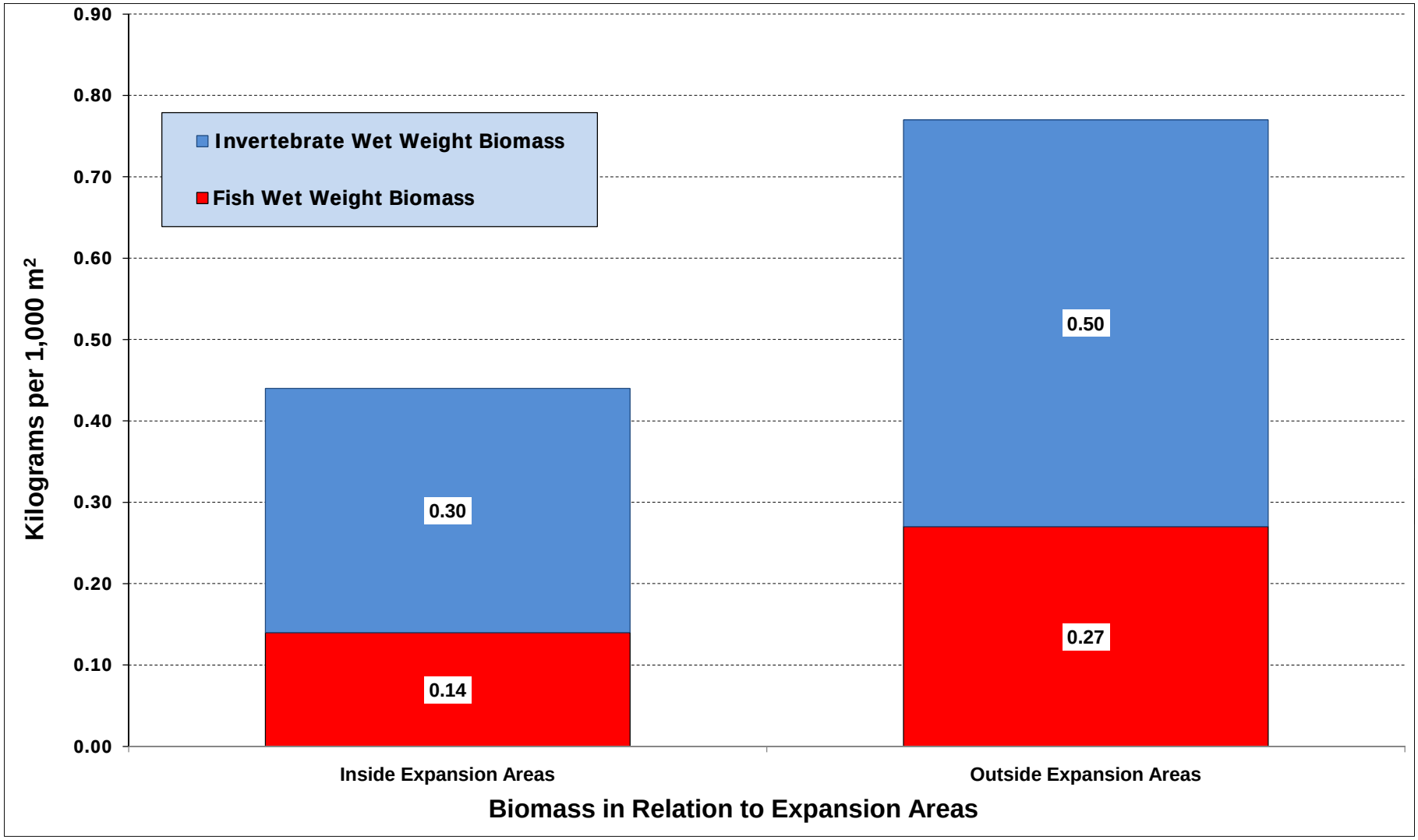
Figure 5. Invertebrate and Fish Biomass per Station Captured by Trawl during the May 2011 Port Everglades Survey



Estimated surface area sampled = length of tow (nmi) x 1,852 (meters per nmi), product x 7.317 (width of trawl in meters).

Source: ANAMAR Environmental Consulting, Inc.

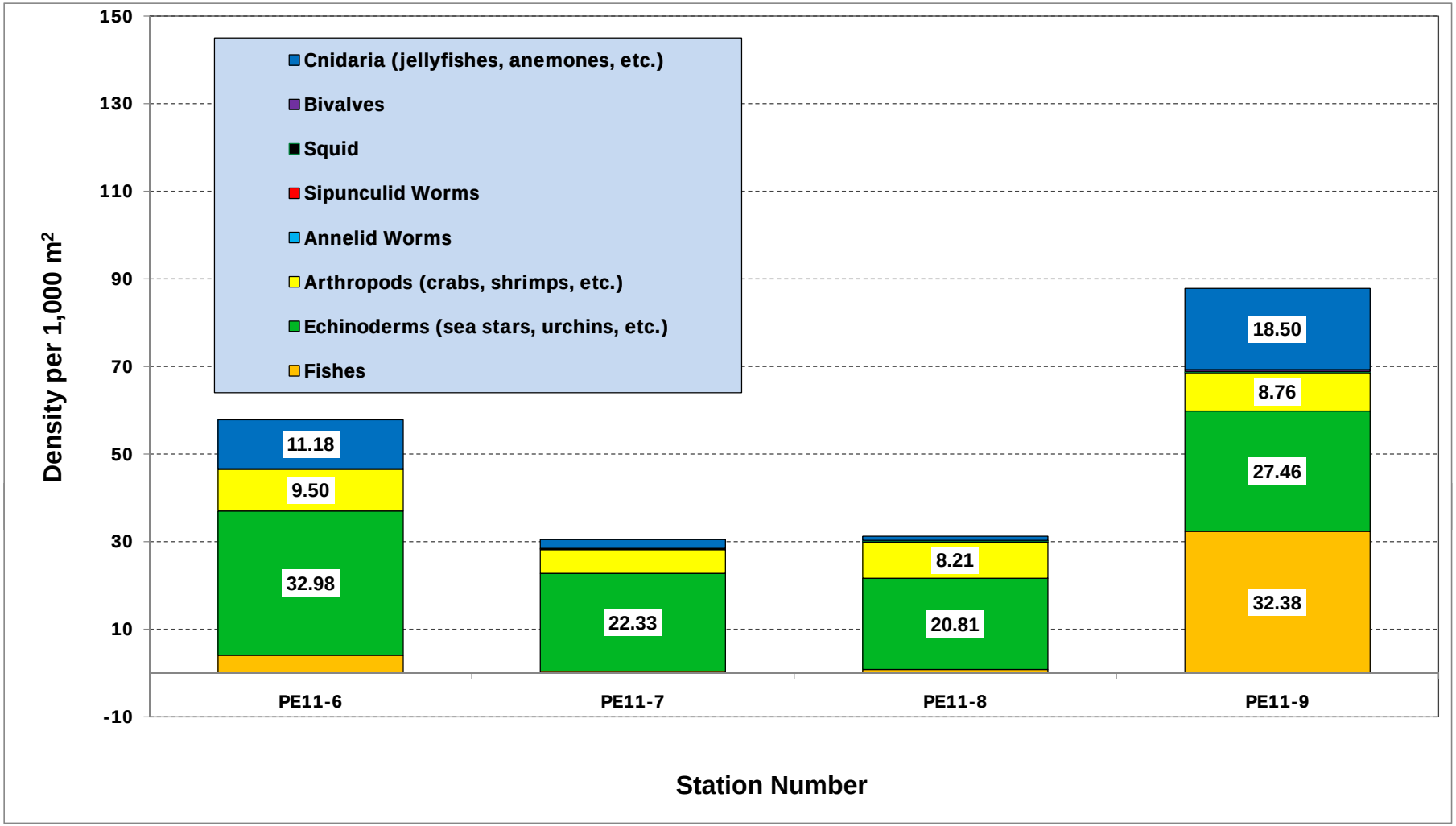
Figure 6. Invertebrate and Fish Biomass in Relation to the Expansion Areas Captured by Trawl during the May 2011 Port Everglades Survey



Notes: Biomass calculated by pooling station data per site and dividing by the estimated surface area sampled.
Estimated surface area sampled = length of tow (nmi) x 1,852 (meters per nmi), product x 7.317 (width of trawl in meters).

Source: ANAMAR Environmental Consulting, Inc.

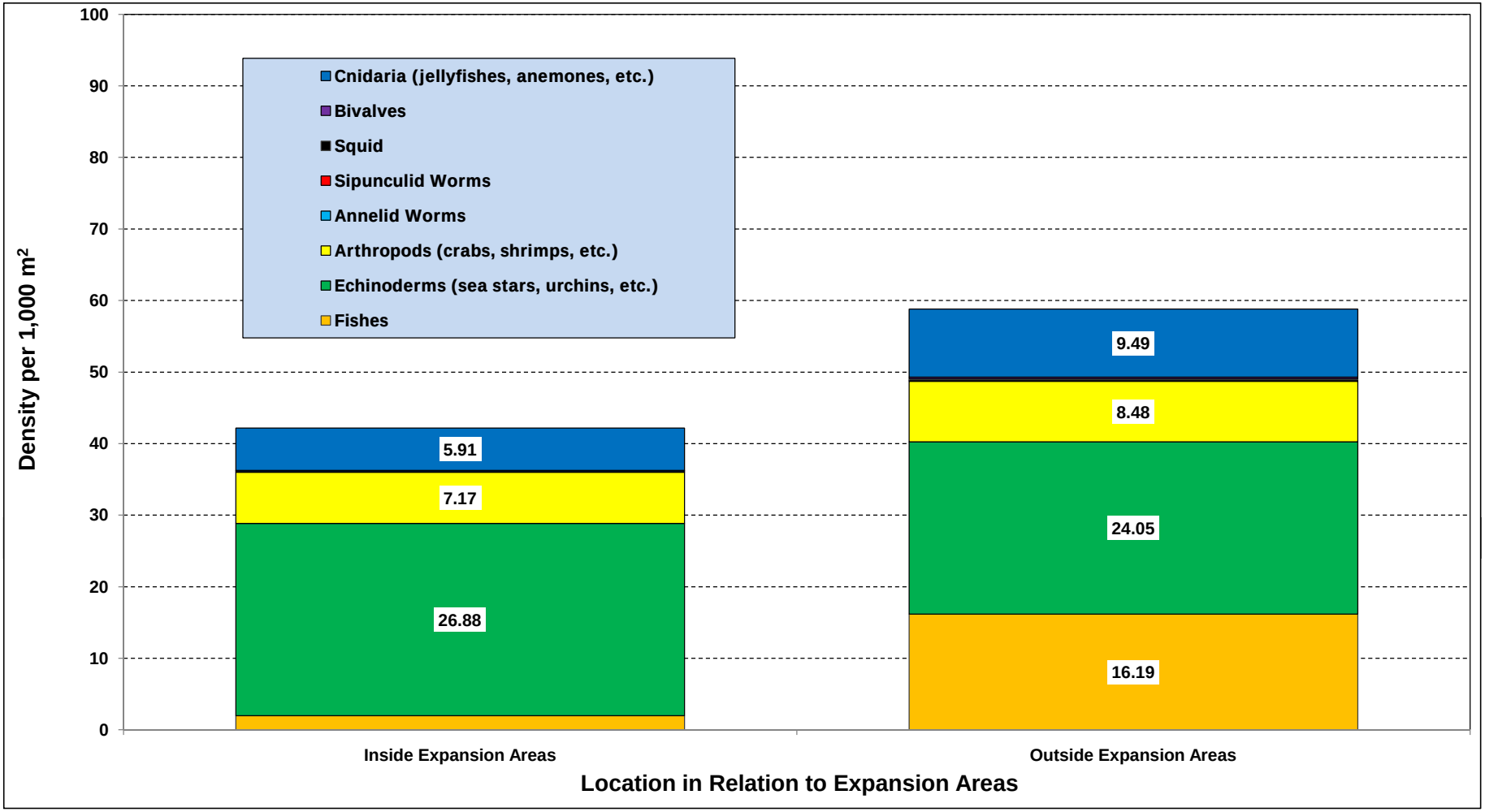
Figure 7. Major Epifaunal Group Densities per Station Captured by Trawl during the May 2011 Port Everglades Survey



Notes: Each major group calculated by summing all species within that major group per station (pooling trawl samples) and dividing by the estimated surface area sampled. Estimated surface area sampled = length of tow (nmi) x 1,852 (meters per nmi), product x 7.317 (width of trawl in meters).

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History Compiled by: ANAMAR Environmental Consulting, Inc.

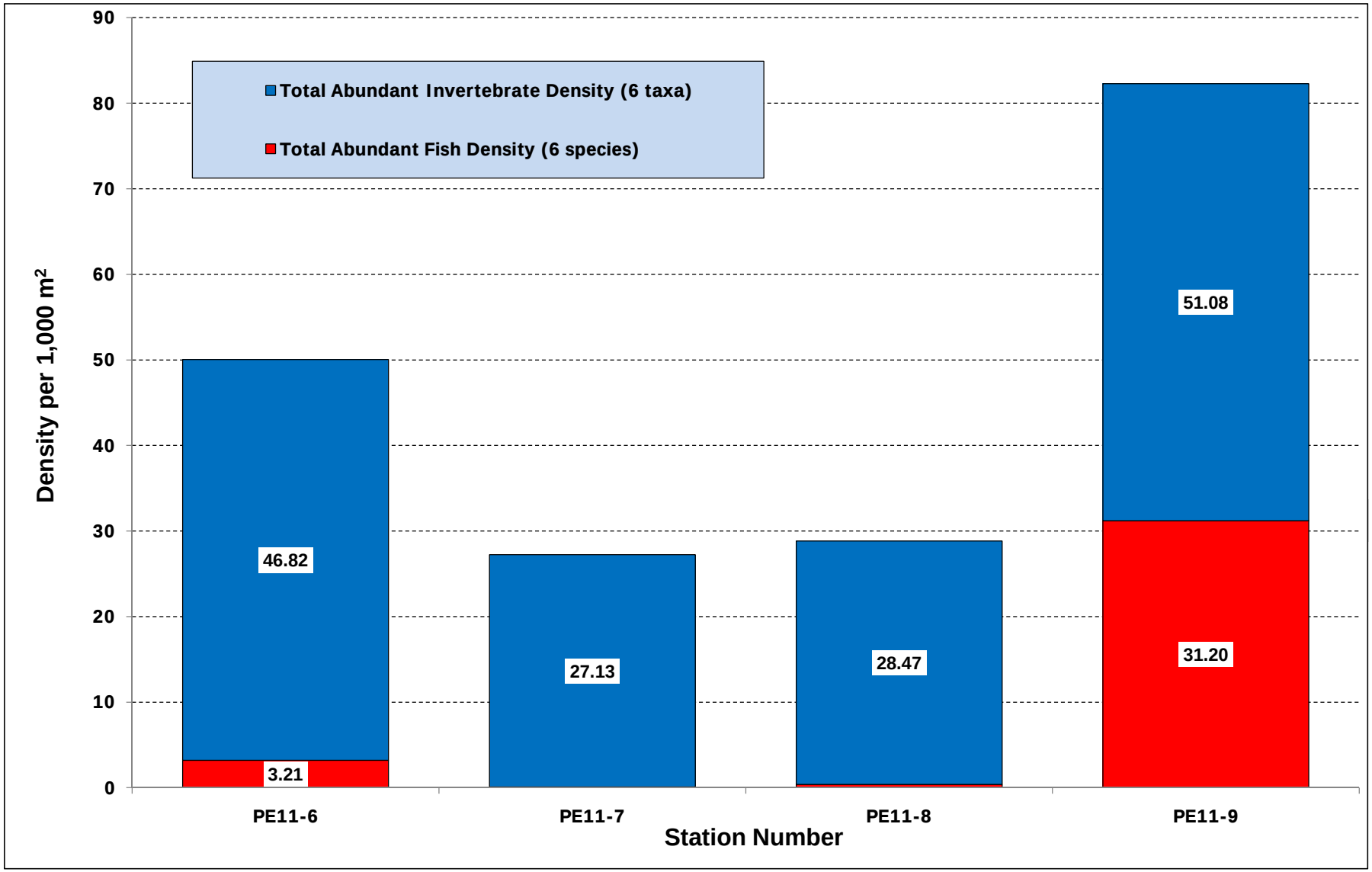
Figure 8. Major Epifaunal Group Densities in Relation to the Expansion Areas Captured by Trawl during the May 2011 Port Everglades Survey



Notes: Each major group calculated by summing all taxa within that major group per area (pooling trawl samples) and dividing by the estimated surface area sampled.
Estimated surface area sampled = length of tow (nmi) x 1,852 (meters per nmi), product x 7.317 (width of trawl in meters).

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History Compiled by: ANAMAR Environmental Consulting, Inc.

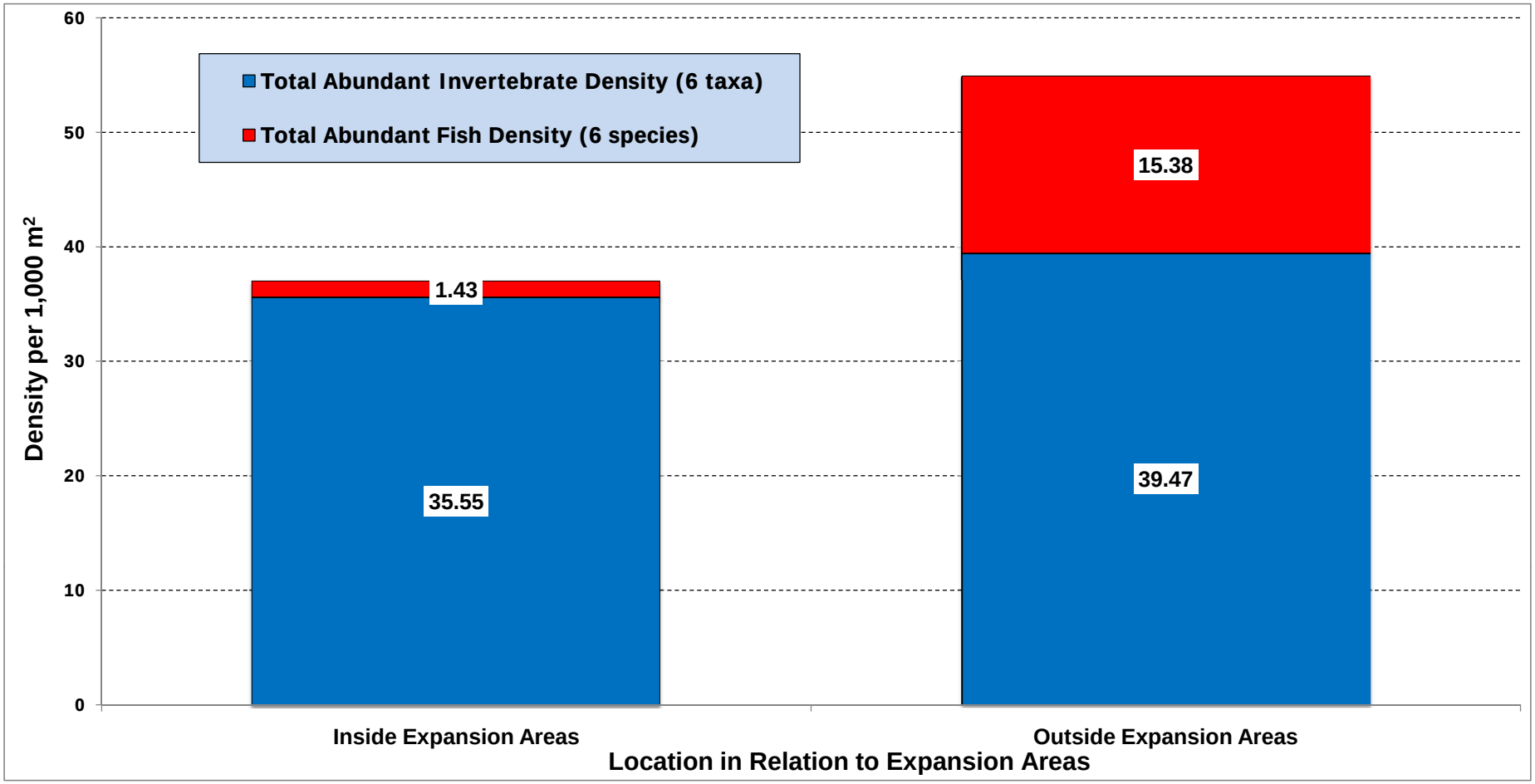
Figure 9. Abundant Trawled Invertebrate and Fish Densities per Station during the May 2011 Port Everglades Survey



Notes: Abundant taxa are those constituting ≥2% of total invertebrates or fishes captured during the trawl survey.
Estimated surface area sampled = length of tow (nmi) x 1,852 (meters per nmi), product x 7.317 (width of trawl in meters). Stations contain pooled samples.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History Compiled by: ANAMAR Environmental Consulting, Inc.

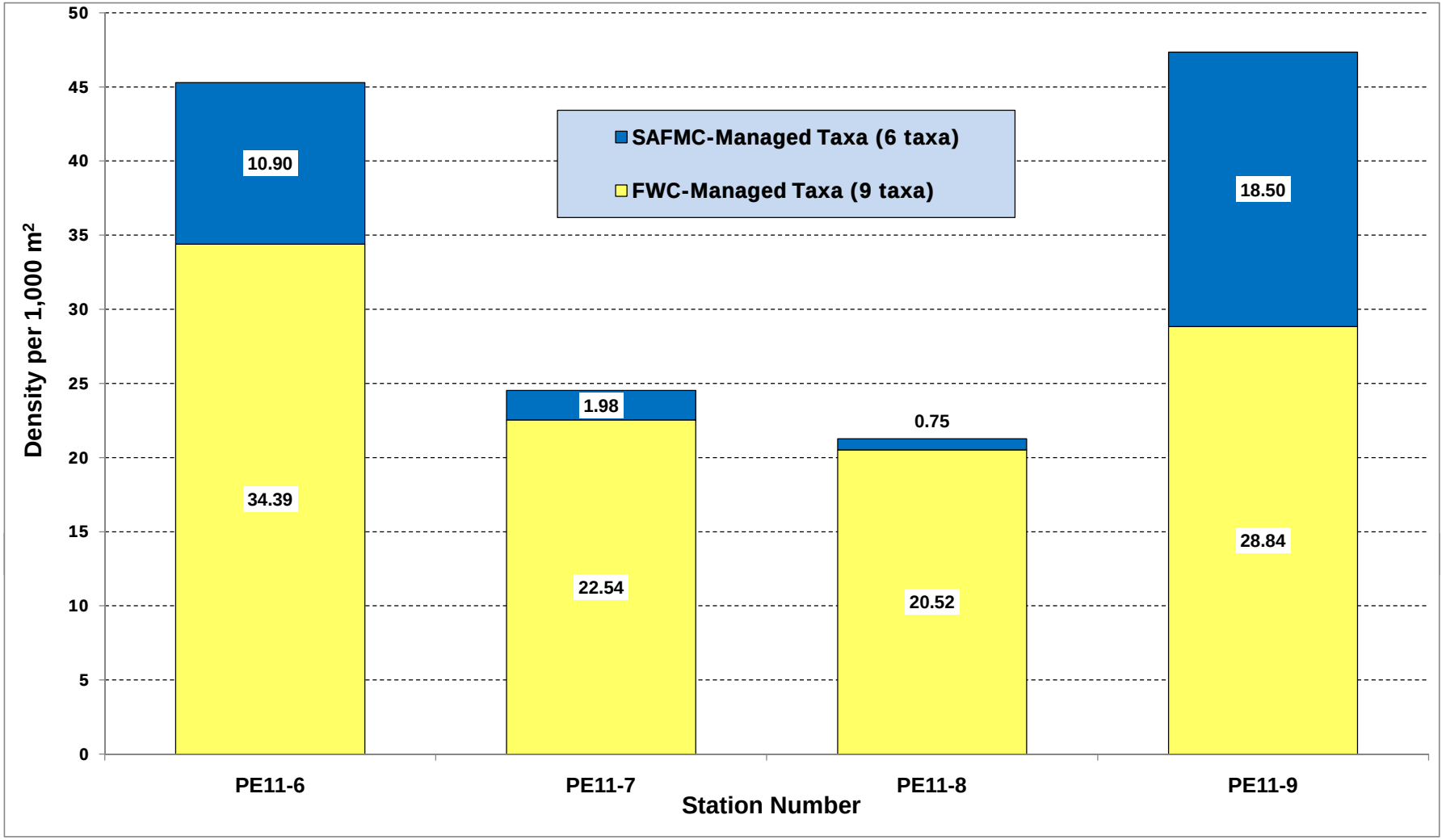
Figure 10. Abundant Trawled Invertebrate and Fish Densities in Relation to the Expansion Areas during the May 2011 Port Everglades Survey



Notes: Abundant taxa are those constituting ≥2% of total invertebrates or fishes captured during the combined trawl surveys.
Estimated surface area sampled = length of tow (nmi) x 1,852 (meters per nmi), product x 7.317 (width of trawl in meters). Areas contain pooled station data.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History Compiled by: ANAMAR Environmental Consulting, Inc.

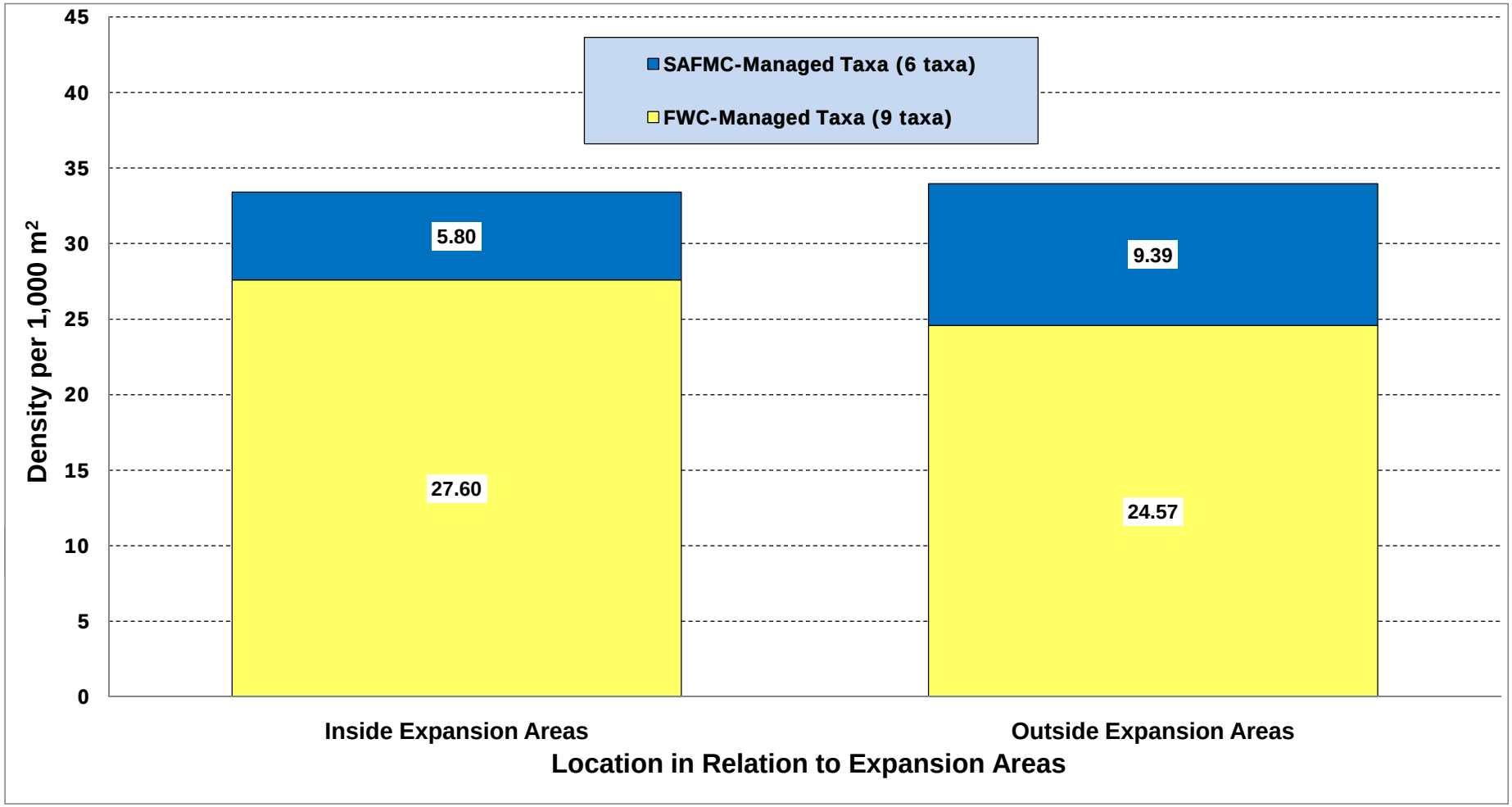
Figure 11. Managed Taxa Densities per Station Captured by Trawl during the May 2011 Port Everglades Survey



SAFMC = South Atlantic Fishery Management Council, which has jurisdiction in Florida east coast federal waters for the six taxa included above.
FWC = Florida Fish and Wildlife Conservation Commission, which includes jurisdiction of federal waters adjacent to Florida for the nine taxa included above.
Estimated surface area sampled = length of tow (nmi) x 1,852 (meters per nmi), product x 7.317 (width of trawl in meters). Stations contain pooled samples.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History Compiled by: ANAMAR Environmental Consulting, Inc.

Figure 12. Managed Taxa Densities in Relation to the Expansion Areas Captured by Trawl during the May 2011 Port Everglades Survey



SAFMC = South Atlantic Fishery Management Council, which has jurisdiction in Florida east coast federal waters for the six taxa included above.
FWC = Florida Fish and Wildlife Conservation Commission, which includes jurisdiction of federal waters adjacent to Florida for the nine taxa included above.
Estimated surface area sampled = length of tow (nmi) x 1,852 (meters per nmi), product x 7.317 (width of trawl in meters). Areas contain pooled station data.

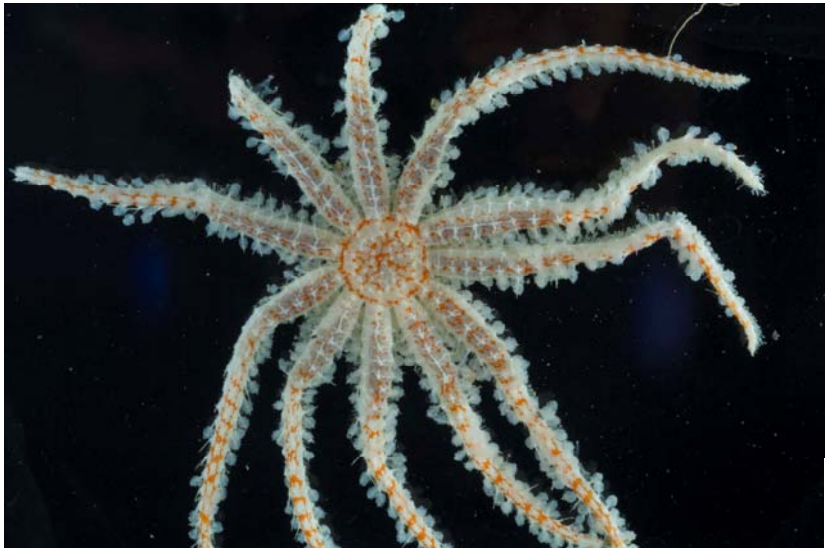
Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History Compiled by: ANAMAR Environmental Consulting, Inc.

Figure 13. Selected Photographs of Epifauna Collected by Trawl during the May 2011 Port Everglades Survey

Actiniaria (sea anemone)
Photo courtesy, A. Bemis and J. Slapcinsky, FLMNH

Cancer borealis (Jonah crab)

Bathynectes longispina (bathyl swimming crab)
Photo courtesy, A. Bemis and J. Slapcinsky, FLMNH



Coronaster briareus (sea star)
Photo courtesy, A. Bemis and J. Slapcinsky, FLMNH

Figure 13 (*continued*). Selected Photographs of Epifauna Collected by Trawl during the May 2011 Port Everglades Survey

Benthobatis marcida (blind torpedo, *n* = 2 juveniles)

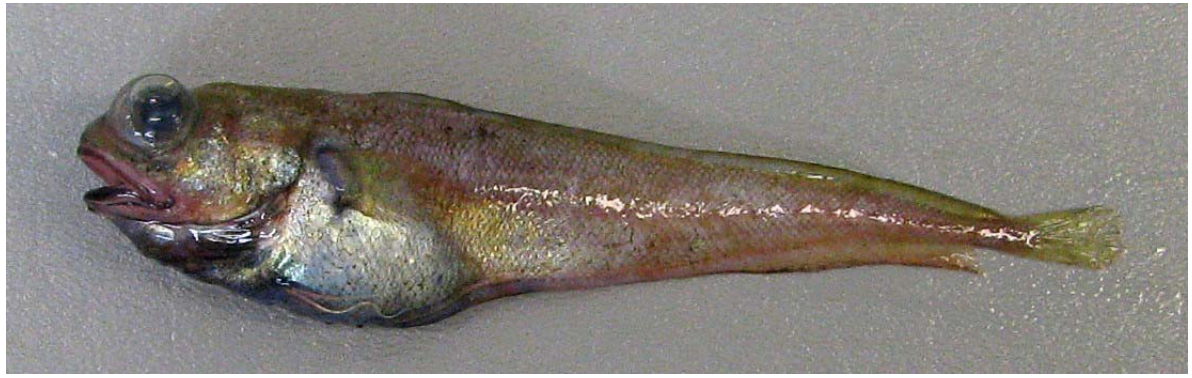
Leucoraja garmani (rosette skate, *n* = 2)

Argentina georgei (argentine)

Chlorophthalmus cf. *agassizi* (shortnose greeneye, *n* = 2)

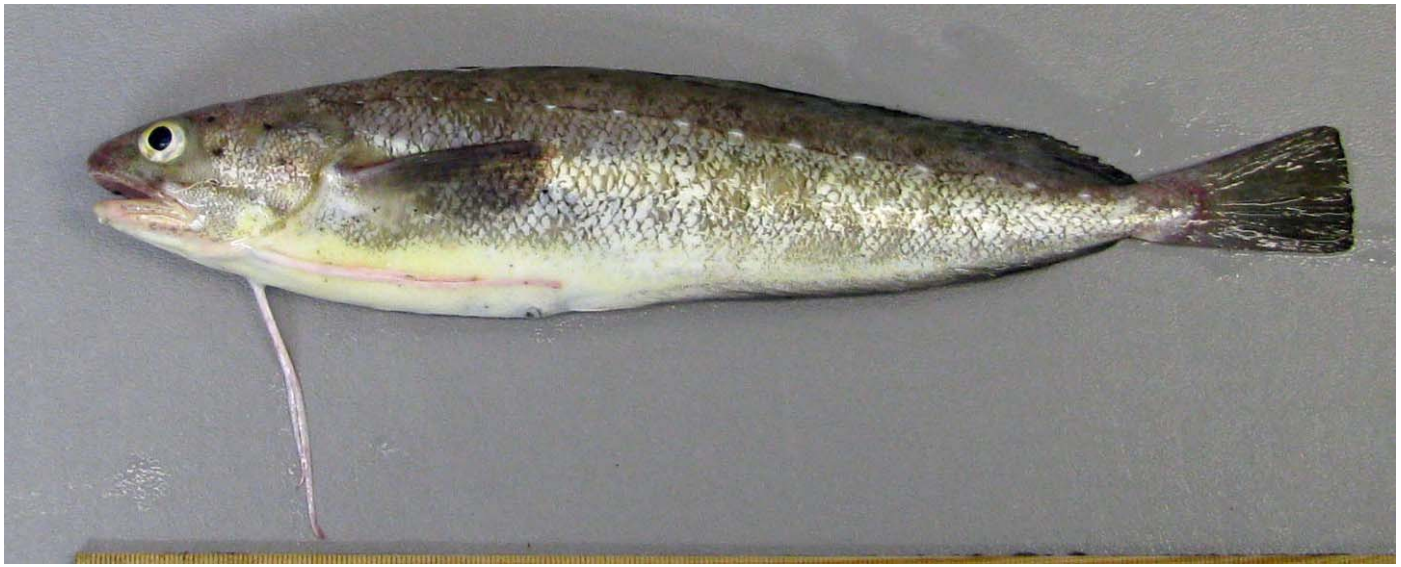
Figure 13 (*continued*). Selected Photographs of Epifauna Collected by Trawl during the May 2011 Port Everglades Survey

Laemonema barbatulum (shortbeard codling)



Physiculus fulvus (metallic codling)

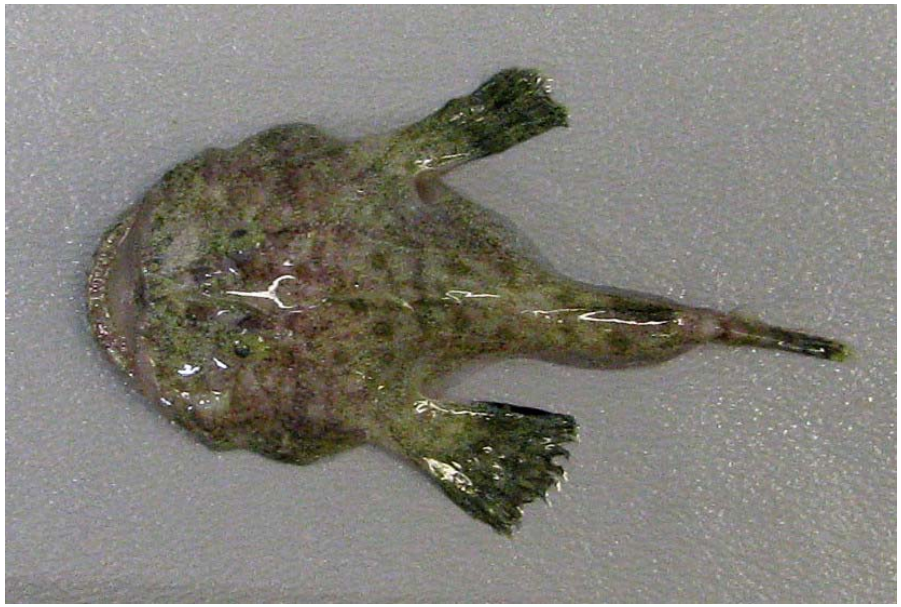
Figure 13 (*continued*). Selected Photographs of Epifauna Collected by Trawl during the May 2011 Port Everglades Survey



Urophycis regia (spotted hake)

Lepophidium profundorum (fawn cusk-eel, *n* = 2)

Figure 13 (*continued*). Selected Photographs of Epifauna Collected by Trawl during the May 2011 Port Everglades Survey



Lophius gastrophysus (blackfin goosefish, juvenile)

Pontinus rathbuni (highfin scorpionfish)

Peristedion thompsoni (rimspine searobin)

Figure 13 (*continued*). Selected Photographs of Epifauna Collected by Trawl during the May 2011 Port Everglades Survey

Synagrops bellus (blackmouth bass)

Caranx ruber (bar jack, juvenile)

Figure 13 (*continued*). Selected Photographs of Epifauna Collected by Trawl during the May 2011 Port Everglades Survey

Elagatis bipinnulata (rainbow runner, juvenile)

Foetorepus agassizii (spotfin dragonet)

Figure 13 (*continued*). Selected Photographs of Epifauna Collected by Trawl during the May 2011 Port Everglades Survey

Paralichthys oblongus (fourspot flounder)

Monolene sessilicauda (deepwater flounder, two size classes [both are juvenile])

ANAMAR Environmental Consulting, Inc.

Tables

TABLE 1
Summary of Field Observations during Sediment Sampling, May 2011 Port Everglades Survey

		ODMDS	Inside Expansion Areas		Outside Expansion Areas	
Sample ID:		**PE11-1-SED**	**PE11-2-SED**	**PE11-3-SED**	**PE11-4-SED**	**PE11-5-SED**
Date / Sampling Time		05/03/11 14:54	05/03/11 13:40	05/03/11 16:17	05/03/11 17:32	05/03/11 12:09
Latitude[1] (N)		26° 7.3238982'	26° 6.993102'	26° 8.2894014'	26° 9.0038988'	26° 5.0059002'
Longitude[1] (W)		80° 1.5077028'	80° 2.3026008'	80° 2.5097028'	80° 2.2972992'	80° 2.3170032'
Water Depth (m)		215.5	196.2	184.2	187.0	205.5
Water Depth (ft)		706.8	643.5	604.2	613.4	674.0
Est. Penetration Depth (cm)		Not recorded	Not recorded	13	12	11
Sediment Field Description	**Texture**	Very fine sand	Very fine sand	Fine sand	Very fine sand	Very fine sand
	Color	Greenish gray	Light gray	Greenish gray	Greenish gray	Light gray
	Notes	Worms present, peat-like fibrous organic chunks, no odor	Live worms present, no odor, no organics	No live organisms, no odor, no organics	Live worms, no odor, no organics	Live worms, no odor, no organics
Weather	**Wind**	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots
	Seas	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet
	Tides	Low, slack	Low, outgoing	Low, incoming	Mid, incoming	Low, outgoing
	Skies	Sunny	Sunny	Sunny	Sunny	Partly cloudy
General Conditions and Observations		Collected field split PE11-6-SED; moderate leakage and winnowing	Moderate leakage	No leakage, winnowing, or overfill	No leakage, winnowing, or overfill	Moderate leakage and winnowing

[1] Coordinates taken from onboard DGPS and presented in WGS 84 datum in degrees, decimal minutes format.

Source: ANAMAR Environmental Consulting, Inc.

TABLE 2
Summary of Field Observations and Sampling Area during Epifaunal Sampling, May 2011 Port Everglades Survey

Station Number:		PE11-6 (inside expansion areas)	PE11-7 (inside expansion areas)
Sample ID Near Surface:		PE11-6-WC-NS	(no samples taken)
Sample ID within Thermocline:		PE11-6-WC-AT	
Sample ID within Isotherm:		PE11-6-WC-MT	
Sample ID Near Bottom:		PE11-6-WC-NB	
Associated CTD profile ID:		PE11-6-CTD	PE11-7-CTD
Date of CTD Deployment		5/5/11	5/5/11
Time of CTD Deployment		11:33	10:50
Latitude[1] (N)		26° 7.6239996'	26° 7.6059996'
Longitude[1] (W)		80° 2.364'	80° 1.1689998'
NS Sample Depth (ft, m)		16.4 feet (5.0 m)	
AT Sample Depth (ft, m)		213.2 feet (65.0 m)	
MT Sample Depth (ft, m)		410.0 feet (125.0 m)	
NB Sample Depth (ft, m)		623.2 feet (190.0 m)	
Total Water Depth (m)		190.0	220.0
Total Water Depth (ft)		623.2	721.6
Volume per Sample (L)		3.0	
Water Field Description	Suspended Material?	None	
	Color	Clear	
	Odor	None	
Weather	Wind	NE 10-15 knots	NE 10-15 knots
	Seas	3-4 feet	3-4 feet
	Tides	High, outgoing	High, outgoing
	Skies	Overcast, rain (drizzle)	Overcast, rain (drizzle)
General Conditions and Observations		Stratification present for temperature (25-100 m), salinity (moderate depth), DO (50-100 m), density (25-105 m). No turbidity stratification.	Stratification present for temperature (35-100 m), salinity (80-220 m), DO (55-100 m), density (45-100 m). No turbidity stratification.

[1] Coordinates taken from onboard DGPS and presented in WGS 84 datum in degrees, decimal minutes format.

Source: ANAMAR Environmental Consulting, Inc.

TABLE 3
Summary of Field Observations during Infaunal Sampling, May 2011 Port Everglades Survey

		Inside ODMDS			Inside Expansion Areas						Outside Expansion Areas					
Abbreviated Sample ID:		**1-INF-A**	**1-INF-B**	**1-INF-C**	**2-INF-A**	**2-INF-B**	**2-INF-C**	**3-INF-A**	**3-INF-B**	**3-INF-C**	**4-INF-A**	**4-INF-B**	**4-INF-C**	**5-INF-A**	**5-INF-B**	**5-INF-C**
Sampling Date & Time		05/03/11 14:06	05/03/11 14:21	05/03/11 14:36	05/03/11 12:44	05/03/11 13:03	05/03/11 13:21	05/03/11 15:27	05/03/11 15:42	05/03/11 16:00	05/03/11 16:43	05/03/11 17:02	05/03/11 17:17	05/03/11 11:03	05/03/11 11:31	05/03/11 11:50
Latitude[1] (N)		26° 7.3226982'	26° 7.3163976'	26° 7.3312008'	26° 6.9962004'	26° 6.9933984'	26° 7.0030992'	26° 8.2900974'	26° 8.2788012'	26° 8.2975008'	26° 9.0100008'	26° 9.0050016'	26° 8.9928984'	26° 5.0146026'	26° 5.0026014'	26° 5.0081016'
Longitude[2] (W)		80° 1.4968992'	80° 1.5096972'	80° 1.502097'	80° 2.3049996'	80° 2.3048004'	80° 2.3061972'	80° 2.5125'	80° 2.4936024'	80° 2.5008018'	80° 2.3040984'	80° 2.3002014'	80° 2.3082'	80° 2.3018022'	80° 2.2917978'	80° 2.2895994'
Water Depth (m)		215.6	215.3	215.6	196.4	195.0	196.1	184.0	184.8	184.3	186.4	186.6	186.8	205.5	201.8	205.9
Water Depth (ft)		707.2	706.1	707.2	644.1	639.6	643.2	603.6	606.2	604.6	611.4	612.0	612.7	674.0	661.8	675.3
Estimated Penetration Depth (cm)		7.0	7.0	7.5	7.5	7.0	8.0	6.8	7.0	7.0	7.0	7.0	6.3	Not noted	6.5	8.0
Sediment Field Description	**Texture**	Very fine sand	Very fine sand	Very fine sand	Very fine sand	Very fine sand	Silt/clay/very fine sand	Very fine sand	Very fine sand	Fine sand	Fine sand	Very fine sand	Very fine sand	Very fine sand	Very fine sand	Fine sand
	Color	Greenish gray	Greenish gray	Light gray	Light gray	Light gray	Light gray	Light gray	Greenish gray	Light gray	Greenish gray	Greenish gray	Greenish gray	Light gray	Light gray	Light gray
	Notes	No live organisms, no odor, broken glass in sample	No live organisms, no odor, no organics	No live organisms, no odor, no organics	Live organisms obs., no odor, no organics	Live worms, no odor, no organics	Live worms, no odor, no organics, marble-sized clay balls obs.	No live organisms, no odor, no organics	No live organisms, no odor, no organics	Live worms, no odor, no organics	Live worms, no odor, no organics	No live organisms, no odor, no organics	No live organisms, no odor, no organics	Live organisms obs., no odor, no organics, shell fragments obs.	Live worms, no odor, no organics, small shell fragments obs.	Live worms, no odor, no organics
Weather	**Wind**	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots
	Seas	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet	1–2 feet
	Tides	Low, slack	Low, slack	Low, slack	Low, outgoing	Low, outgoing	Low, outgoing	Low, incoming	Low, incoming	Low, incoming	Mid, incoming	Mid, incoming	Mid, incoming	Low, outgoing	Low, outgoing	Low, outgoing
	Skies	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Not noted	Sunny	Sunny	Sunny	Sunny	Sunny	Sunny	Partly cloudy	Not noted
General Conditions and Observations		No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed	No leakage, winnowing, overfill, or disturbance observed

[1] Coordinates taken from onboard DGPS and presented in WGS 84 datum in degrees, decimal minutes format.

Source: ANAMAR Environmental Consulting, Inc.

TABLE 4
Summary of Field Observations and Sampling Area during Epifaunal Sampling, May 2011 Port Everglades Survey

		Trial Tow	Inside Expansion Areas				Outside Expansion Areas				Tissue-Only Trawls (not part of epifaunal analysis)			
Abbreviated Sample ID:		**5-EPI-A**	**6-EPI-A**	**6-EPI-B**	**7-EPI-A**	**7-EPI-B**	**8-EPI-A**	**8-EPI-B**	**9-EPI-A**	**9-EPI-B**	**5T2 (tissue trawl)**	**10T3 (tissue trawl)**	**13T1 (tissue trawl)**	**14T1 (tissue trawl)**
Date		05/04/11	05/05/11	05/05/11	05/05/11	05/05/11	05/04/11	05/04/11	05/04/11	05/05/11	05/05/11	05/05/11	05/05/11	05/05/11
Time at Start of Tow		9:29	13:06	0:10	1:58	14:35	11:12	20:22	12:56	22:24	20:38	22:32	18:47	16:33
Time at End of Tow		9:44	13:20	0:25	2:14	14:56	11:28	20:42	13:11	22:39	21:08	23:02	19:17	17:13
Day or Night Trawl		Day	Day	Night	Night	Day	Day	Night	Day	Night	Night	Night	Day	Day
Start Latitude[1] (N)		26° 4.9056018'	26° 8.2534542'	26° 8.0652972'	26° 7.871463'	26° 7.8632154'	26° 6.0338538'	26° 5.5523622'	26° 7.2560898'	26° 7.3136196'	26° 5.1904776'	26° 5.4769818'	26° 8.9174166'	26° 9.0908922'
Start Longitude[1] (W)		80° 2.3331018'	80° 2.2742262'	80° 2.2771908'	80° 1.1662458'	80° 1.14756599'	80° 1.8130296'	80° 1.7885682'	80° 2.794779'	80° 2.9813886'	80° 2.3351484'	80° 2.9812842'	80° 2.351736'	80° 1.8458976'
End Latitude[1] (N)		26° 4.5320988'	26° 8.0198766'	26° 7.7897994'	26° 7.5342642'	26° 7.4947782'	26° 5.6415024'	26° 5.1583884'	26° 6.9546018'	26° 6.8753826'	26° 4.2589188'	26° 4.4972748'	26° 7.9399734'	26° 8.0353464'
End Longitude[1] (W)		80° 2.3817'	80° 2.3784684'	80° 2.279076'	80° 1.1563686'	80° 1.1342244'	80° 1.760049'	80° 1.7868744'	80° 2.7381246'	80° 2.911755'	80° 2.4310638'	80° 3.0547314'	80° 2.4366648'	80° 1.7660844'
Mean Water Depth (m)		207.0	193.0	197.5	224.0	222.0	218.0	218.0	178.5	192.0	216.0	190.0	188.5	205.0
Mean Water Depth (ft)		679.0	633.0	647.8	734.7	728.2	715.0	715.0	585.5	629.8	708.5	623.2	618.3	672.4
Direction of Tow		South	South	South	South	South	South	South	South	South-southwest	South	South	South	South
Tow Speed or Range (knots)		1.4	1.1	1.7	1.1	1.8	1.5	1.5	1.3	1.5	1.7	Not noted	1.6	1.7
Duration of Tow (minutes)		15	14	15	16	21	16	20	15	15	30	30	30	40
Length of Tow (nmi)[2]		0.377	0.252	0.276	0.338	0.369	0.396	0.395	0.306	0.444	0.937	0.984	0.982	1.060
Estimated Surface Area Sampled[3] (m^2)		5,105	3,415	3,740	4,579	5,004	5,365	5,349	4,151	6,010	12,700	13,330	13,310	14,363
Weather	**Wind**	E 0–5 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 5–10 knots	E 0–5 knots	E 5–10 knots	E 0–5 knots	E 5–10 knots	NE 10–15 knots	NE 10–15 knots	NE >15 knots	NE >15 knots
	Seas	1–2 feet	3–4 feet	3–4 feet	3–4 feet	3–4 feet	1–2 feet	1–2 feet	1–2 feet	3–4 feet	3–4 feet	3–4 feet	3–4 feet	3–4 feet
	Tides	Mid, outgoing	Not noted	Mid, outgoing	Mid, outgoing	Not noted	Mid, outgoing	Mid, outgoing	Mid, outgoing	Mid, outgoing	Mid, incoming	High, outgoing	Mid, incoming	Low, incoming
	Skies	Sunny	Rain (drizzle)	Clear, dark	Clear, dark	Cloudy	Sunny	Clear, dark	Sunny	Clear, dark	Clear, dark	Rain (drizzle)	Cloudy	Cloudy
Water Temperature[4] (°C)		27.8	27.2	27.2	27.2	27.2	27.8	28.9	27.8	27.2	27.8	27.8	27.8	27.8
Trawl Performance and Other Observations		Trial run of trawl. 3:1 ratio of cable to depth was not long enough, only contacted seafloor some of time	Used 5:1 scope, trawl contacted seafloor during a portion or all of tow (wear patterns difficult to see)	Trawl contacted seafloor during portion or all of tow; large metal debris in net, did not damage trawl	1:5 ratio, contacted seafloor during portion or all of tow, cable twisted, rocks and coral fragments in net	1:5 or more scope, contacted seafloor during full duration of tow, no problems	4:1 ratio used, chain twisted, swivel not working well, on bottom portion or all of tow, carbonate rocks caught	4:1 ratio used, still no significant wear on door shoes, stern cable pointed nearly straight down	4:1 ratio used, bridle twisted but didn't interfer with tow, contacted seafloor full duration, rocks and coal in sample	5:1 ratio used, contacted seafloor throughout tow, snagged long rope on bridle, had to cut rope	Tissue trawl, much debris in net (cans, hat, bottles); some hake and and Jonah crabs caught	Tissue trawl, debris in net (trash, aluminum, bottles, cloth); spotted hake and Jonah crabs caught	Tissue trawl, no apparent problems with gear; low numbers of epifauna captured, some Jonah crabs caught	Tissue trawl, variable speed of tow, Jonah crabs caught

[1] Coordinates taken from onboard DGPS and presented in WGS 84 datum in degrees, decimal minutes format.

[2] Length of tow was calculated from start and end coordinates using the website http://www2.nau.edu/~cvm/latlongdist.html.

[3] Estimated surface area sampled calculated by multiplying length of tow by 1852 (meters per nmi) and multiplying the product by 7.317 (width of trawl in meters).

[4] Water temperature was recorded near the surface from ship-based temperature-sensing equipment and converted from Fahrenheit. Accuracy of this equipment has not been evaluated.

Source: ANAMAR Environmental Consulting, Inc.

TABLE 5
CTD Water Column Profile taken at Station PE11-6 during the May 2011 Port Everglades Survey

Sequence	Depth (m)	Depth (ft)	Dissolved Oxygen (mg/L)	Salinity (ppt)	Temperature (°C)	Turbidity (FTU)	PAR (PAR Units)	Surface PAR (PAR Units)	Normalized PAR (%)
Descent	0	0.0	6.6	36.2	***26.7***	0.3	***250***	**504**	***49.6***
Descent	5	16.4	6.7	36.2	***26.7***	0.2	199	506	39.4
Descent	10	32.8	6.7	36.2	***26.7***	**0.1**	147	511	28.7
Descent	15	49.2	6.7	36.2	***26.7***	**0.1**	119	516	23.0
Descent	20	65.6	6.7	36.2	***26.7***	**0.1**	106	522	20.3
Descent	25	82.0	6.7	36.2	26.6	**0.1**	92.3	527	17.5
Descent	30	98.4	6.8	36.2	26.4	**0.1**	78.9	533	14.8
Descent	35	114.8	6.9	36.3	26.3	**0.1**	65.1	539	12.1
Descent	40	131.2	6.9	36.3	25.9	**0.1**	52.7	544	9.7
Descent	45	147.6	7.0	36.3	25.4	0.2	42.4	549	7.7
Descent	50	164.0	7.1	***36.4***	24.7	0.2	33.2	554	6.0
Descent	55	180.4	***7.2***	36.3	23.7	0.3	24.0	559	4.3
Descent	60	196.8	7.0	36.2	22.0	***0.5***	13.6	562	2.4
Descent	65	213.2	6.7	36.2	20.5	0.3	7.3	566	1.3
Descent	70	229.6	6.5	36.2	19.6	0.3	4.7	570	0.8
Descent	75	246.0	6.2	36.1	18.1	0.3	3.6	574	0.6
Descent	80	262.4	5.6	36.0	16.9	0.2	3.0	578	0.5
Descent	85	278.8	5.4	36.0	16.3	0.2	2.7	582	0.5
Descent	90	295.2	5.1	35.9	15.1	0.2	2.5	586	0.4
Descent	95	311.6	4.7	35.8	14.4	0.3	2.4	589	0.4
Descent	100	328.0	4.5	35.8	14.2	0.2	2.3	593	0.4
Descent	105	344.4	4.4	35.8	14.0	0.2	2.2	597	0.4
Descent	110	360.8	4.4	35.8	13.9	0.2	2.1	600	0.4
Descent	115	377.2	4.4	35.8	13.8	0.2	2.1	603	0.3
Descent	120	393.6	4.3	35.8	13.8	0.2	2.0	606	0.3
Descent	125	410.0	4.3	35.8	13.8	0.2	2.0	610	0.3
Descent	130	426.4	4.3	35.7	13.7	0.2	1.9	612	0.3
Descent	135	442.8	4.3	35.7	13.7	0.2	1.9	616	0.3
Descent	140	459.2	4.3	35.7	13.5	0.2	1.8	619	0.3
Descent	145	475.6	4.3	35.7	13.4	0.2	1.8	622	0.3
Descent	150	492.0	4.3	35.6	12.6	0.2	1.8	625	0.3
Descent	155	508.4	4.3	35.5	11.6	0.2	1.7	628	0.3
Descent	160	524.8	4.3	35.4	10.7	0.2	1.7	630	0.3
Descent	165	541.2	4.3	35.3	10.0	0.2	1.7	633	0.3
Descent	170	557.6	**4.2**	35.2	9.5	0.2	1.6	636	0.3
Descent	175	574.0	**4.2**	35.1	9.0	0.2	1.6	639	**0.2**
Descent	180	590.4	**4.2**	35.1	8.7	0.2	1.5	641	**0.2**
Descent	185	606.8	**4.2**	35.1	8.5	0.3	1.5	644	**0.2**
Descent	190	623.2	**4.2**	**35.0**	**8.4**	0.2	1.4	654	**0.2**
Ascent	185	606.8	**4.2**	**35.0**	8.5	0.3	1.3	662	**0.2**
Ascent	180	590.4	**4.2**	35.1	8.6	0.2	1.3	666	**0.2**
Ascent	175	574.0	**4.2**	35.1	8.9	0.2	1.3	669	**0.2**
Ascent	170	557.6	**4.2**	35.2	9.4	0.2	**1.2**	672	**0.2**
Ascent	165	541.2	**4.2**	35.2	9.9	0.2	**1.2**	676	**0.2**
Ascent	160	524.8	**4.2**	35.3	10.5	0.2	**1.2**	679	**0.2**
Ascent	155	508.4	4.3	35.4	11.3	0.2	**1.2**	682	**0.2**
Ascent	150	492.0	**4.2**	35.5	12.2	0.2	**1.2**	686	**0.2**
Ascent	145	475.6	4.3	35.7	13.1	0.2	**1.2**	689	**0.2**
Ascent	140	459.2	4.3	35.7	13.5	0.2	**1.2**	693	**0.2**
Ascent	135	442.8	4.3	35.7	13.6	0.2	**1.2**	696	**0.2**
Ascent	130	426.4	4.3	35.7	13.7	0.2	**1.2**	700	**0.2**
Ascent	125	410.0	4.3	35.7	13.8	0.2	**1.2**	710	**0.2**
Ascent	120	393.6	4.3	35.8	13.8	0.2	**1.2**	721	**0.2**
Ascent	115	377.2	4.3	35.8	13.8	0.2	**1.2**	725	**0.2**
Ascent	110	360.8	4.3	35.8	13.8	0.2	1.3	729	**0.2**
Ascent	105	344.4	4.4	35.8	13.9	0.2	1.3	733	**0.2**
Ascent	100	328.0	4.4	35.8	14.1	0.2	1.4	736	**0.2**
Ascent	95	311.6	4.5	35.8	14.4	0.2	1.4	740	**0.2**
Ascent	90	295.2	4.7	35.9	15.2	0.2	1.6	744	**0.2**
Ascent	85	278.8	5.2	35.9	16.3	0.2	1.8	747	**0.2**
Ascent	80	262.4	5.4	36.0	17.0	0.2	2.3	750	0.3
Ascent	75	246.0	5.7	36.0	18.0	0.2	3.2	752	0.4
Ascent	70	229.6	6.2	36.1	19.5	0.2	5.1	755	0.7
Ascent	65	213.2	6.5	36.2	20.4	0.3	9.4	762	1.2
Ascent	60	196.8	6.8	36.2	22.0	0.3	19	772	2.5
Ascent	55	180.4	7.0	36.3	23.9	0.3	32	776	4.1
Ascent	50	164.0	7.1	36.3	24.9	0.1	43	780	5.5
Ascent	45	147.6	7.0	36.3	25.6	0.1	56	784	7.2
Ascent	40	131.2	6.9	36.3	26.0	0.1	71	788	9.0
Ascent	35	114.8	6.8	36.2	26.3	0.1	89	792	11.3
Ascent	30	98.4	6.8	36.2	26.5	0.1	112	797	14.0
Ascent	25	82.0	6.7	36.2	26.6	0.1	134	801	16.8
Ascent	20	65.6	6.7	36.2	26.7	0.1	158	806	19.6
Ascent	15	49.2	6.7	36.2	26.7	0.1	181	811	22.3
Ascent	10	32.8	6.7	36.2	26.7	0.1	212	815	25.9
Ascent	5	16.4	6.7	36.2	26.7	0.1	295	827	35.7
Ascent	0	0.0	6.7	36.2	26.7	0.2	***350***	***834***	*41.9*

Numbers in bold represent the minimum value for the parameter at Station PE11-6.
Numbers in bold and italics represent the maximum value for the parameter at Station PE11-6.
Green shading indicates the presence of an isothermic layer.
Orange shading indicates the presence of a thermocline (≥1°C change per 5 m depth).
Note: Station PE11-6 is located within the west-central portion of the expansion areas. Profile was recorded on 5/5/11 at 11:33. 5-m bin averaging was used for table.

Source: U.S. Environmental Protection Agency Post-processed and compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 6
CTD Water Column Profile taken at Station PE11-7 during the May 2011 Port Everglades Survey

Sequence	Depth (m)	Depth (ft)	Dissolved Oxygen (mg/L)	Salinity (ppt)	Temperature (°C)	Turbidity (FTU)	PAR (PAR Units)	Surface PAR (PAR Units)	Normalized PAR (%)
Descent	0	0.0	6.7	36.2	***26.7***	***1.8***	***509***	***532***	***95.5***
Descent	5	16.4	6.7	36.2	***26.7***	**0.1**	181	530	34.2
Descent	10	32.8	6.7	36.2	***26.7***	**0.1**	116	527	22.0
Descent	15	49.2	6.7	36.2	***26.7***	**0.1**	108	523	20.8
Descent	20	65.6	6.8	36.2	***26.7***	**0.1**	102	519	19.7
Descent	25	82.0	6.7	36.2	26.6	**0.1**	90.8	515	17.6
Descent	30	98.4	6.8	36.2	26.5	0.2	74.4	512	14.5
Descent	35	114.8	6.8	36.3	26.2	0.2	60.1	512	11.7
Descent	40	131.2	6.9	36.3	26.0	0.2	48.6	512	9.5
Descent	45	147.6	7.0	36.3	25.5	0.2	38.2	512	7.5
Descent	50	164.0	7.2	***36.4***	24.6	0.2	29.5	513	5.8
Descent	55	180.4	***7.3***	***36.4***	23.5	0.2	21.9	513	4.3
Descent	60	196.8	7.2	36.3	22.3	0.3	14.4	515	2.8
Descent	65	213.2	6.8	36.3	20.7	0.3	8.6	515	1.7
Descent	70	229.6	6.5	36.3	19.6	0.2	5.7	516	1.1
Descent	75	246.0	6.1	36.3	18.9	0.2	4.3	515	0.8
Descent	80	262.4	5.8	36.1	17.5	0.3	3.5	514	0.7
Descent	85	278.8	5.3	36.0	16.3	0.2	3.1	512	0.6
Descent	90	295.2	5.1	35.9	15.7	0.3	2.8	509	0.5
Descent	95	311.6	5.0	35.9	15.0	0.3	2.6	504	0.5
Descent	100	328.0	4.6	35.8	14.3	0.2	2.4	500	0.5
Descent	105	344.4	4.5	35.8	14.1	0.2	2.3	494	0.5
Descent	110	360.8	4.4	35.8	14.0	0.2	2.2	488	0.5
Descent	115	377.2	4.3	35.8	13.9	0.2	2.2	480	0.5
Descent	120	393.6	4.3	35.8	13.8	0.2	2.1	473	0.4
Descent	125	410.0	4.3	35.8	13.7	0.2	2.0	466	0.4
Descent	130	426.4	4.3	35.7	13.7	0.2	2.0	457	0.4
Descent	135	442.8	4.3	35.7	13.6	0.2	1.9	450	0.4
Descent	140	459.2	4.3	35.7	13.5	0.2	1.9	444	0.4
Descent	145	475.6	4.3	35.7	13.3	0.2	1.8	440	0.4
Descent	150	492.0	4.3	35.6	12.5	0.2	1.8	437	0.4
Descent	155	508.4	4.4	35.5	11.8	**0.1**	1.8	437	0.4
Descent	160	524.8	4.4	35.5	11.5	**0.1**	1.7	435	0.4
Descent	165	541.2	4.4	35.3	10.4	**0.1**	1.7	432	0.4
Descent	170	557.6	4.3	35.3	10.0	**0.1**	1.6	427	0.4
Descent	175	574.0	4.3	35.2	9.6	**0.1**	1.6	422	0.4
Descent	180	590.4	**4.2**	35.2	9.3	**0.1**	1.6	419	0.4
Descent	185	606.8	**4.2**	35.1	9.2	**0.1**	1.5	419	0.4
Descent	190	623.2	**4.2**	35.1	9.1	**0.1**	1.5	421	0.4
Descent	195	639.6	**4.2**	35.1	8.9	**0.1**	1.5	427	**0.3**
Descent	200	656.0	**4.2**	35.1	8.7	**0.1**	1.4	434	**0.3**
Descent	205	672.4	**4.2**	35.1	8.6	**0.1**	1.4	440	**0.3**
Descent	210	688.8	**4.2**	**35.0**	8.4	0.2	1.4	444	**0.3**
Descent	215	705.2	**4.2**	**35.0**	8.3	0.2	1.3	447	**0.3**
Descent	220	721.6	**4.2**	**35.0**	**8.1**	**0.1**	1.3	447	**0.3**
Ascent	215	705.2	**4.2**	**35.0**	8.3	0.2	1.3	443	**0.3**
Ascent	210	688.8	**4.2**	**35.0**	8.4	0.2	1.2	439	**0.3**
Ascent	205	672.4	**4.2**	35.1	8.5	**0.1**	1.2	436	**0.3**
Ascent	200	656.0	**4.2**	35.1	8.7	**0.1**	1.2	432	**0.3**
Ascent	195	639.6	**4.2**	35.1	8.9	**0.1**	1.2	429	**0.3**
Ascent	190	623.2	**4.2**	35.1	9.1	**0.1**	**1.1**	425	**0.3**
Ascent	185	606.8	**4.2**	35.1	9.2	**0.1**	**1.1**	422	**0.3**
Ascent	180	590.4	**4.2**	35.2	9.3	**0.1**	**1.1**	419	**0.3**
Ascent	175	574.0	**4.2**	35.2	9.5	**0.1**	**1.1**	415	**0.3**
Ascent	170	557.6	4.3	35.2	9.9	**0.1**	**1.1**	411	**0.3**
Ascent	165	541.2	4.3	35.3	10.2	**0.1**	**1.1**	409	**0.3**
Ascent	160	524.8	4.3	35.4	11.3	**0.1**	**1.1**	407	**0.3**
Ascent	155	508.4	4.3	35.5	11.7	**0.1**	**1.1**	404	**0.3**
Ascent	150	492.0	4.3	35.6	12.3	**0.1**	**1.1**	404	**0.3**
Ascent	145	475.6	4.3	35.7	13.1	0.2	**1.1**	402	**0.3**
Ascent	140	459.2	4.3	35.7	13.4	0.2	**1.1**	399	**0.3**
Ascent	135	442.8	4.3	35.7	13.6	0.2	**1.1**	397	**0.3**
Ascent	130	426.4	4.3	35.7	13.7	0.2	**1.1**	395	**0.3**
Ascent	125	410.0	4.3	35.7	13.7	0.2	**1.1**	392	**0.3**
Ascent	120	393.6	4.3	35.8	13.8	0.2	**1.1**	390	**0.3**
Ascent	115	377.2	4.3	35.8	13.9	0.2	**1.1**	389	**0.3**
Ascent	110	360.8	4.3	35.8	14.0	0.2	**1.1**	391	**0.3**
Ascent	105	344.4	4.4	35.8	14.1	0.2	1.2	393	**0.3**
Ascent	100	328.0	4.5	35.8	14.4	0.2	1.2	393	**0.3**
Ascent	95	311.6	4.8	35.9	15.2	0.2	1.3	393	**0.3**
Ascent	90	295.2	5.1	35.9	15.8	0.2	1.4	391	0.4
Ascent	85	278.8	5.2	36.0	16.5	0.2	1.6	389	0.4
Ascent	80	262.4	5.6	36.2	18.2	0.2	2.0	389	0.5
Ascent	75	246.0	6.0	36.3	19.1	0.2	2.6	387	0.7
Ascent	70	229.6	6.3	36.3	19.9	0.2	3.7	387	1.0
Ascent	65	213.2	6.7	36.2	20.8	0.3	6.1	386	1.6
Ascent	60	196.8	7.0	36.3	22.4	0.3	10.3	383	2.7
Ascent	55	180.4	7.3	36.3	23.4	0.2	15.4	383	4.0
Ascent	50	164.0	7.2	36.3	24.6	0.2	21.1	382	5.5
Ascent	45	147.6	7.0	36.3	25.5	**0.1**	27.6	381	7.2
Ascent	40	131.2	6.9	36.3	26.0	0.2	35.6	381	9.4
Ascent	35	114.8	6.9	36.3	26.3	**0.1**	45.2	381	11.9
Ascent	30	98.4	6.8	36.2	26.5	**0.1**	56.7	381	14.9
Ascent	25	82.0	6.7	36.2	26.6	**0.1**	70.8	380	18.6
Ascent	20	65.6	6.7	36.2	26.7	**0.1**	87.2	379	23.0
Ascent	15	49.2	6.7	36.2	26.7	**0.1**	106	378	28.2
Ascent	10	32.8	6.7	36.2	26.7	**0.1**	132	376	35.2
Ascent	5	16.4	6.7	36.2	26.7	**0.1**	181	374	48.2
Ascent	0	0.0	6.7	36.2	26.7	0.3	352	**373**	94.4

Numbers in bold represent the minimum value for the parameter at Station PE11-7.
Numbers in bold and italics represent the maximum value for the parameter at Station PE11-7.
Green shading indicates the presence of an isothermic layer.
Orange shading indicates the presence of a thermocline (≥1°C change per 5 m depth).

Note: Station PE11-7 is located within the east-central portion of the expansion areas. Profile was recorded on 5/5/11 at 10:50. 5-m bin averaging was used for table.

Source: U.S. Environmental Protection Agency Post-processed and compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 7
Results of Total Suspended Solids Analysis of Water Collected during the May 2011 Port Everglades Survey

				Station PE11-6 (Inside Expansion Areas)															
Abbreviated Sample ID:				6-WC-NS				6-WC-NS (Field Split)				6-WC-AT				6-WC-MT				6-WC-NB			
Position within Water Column:				Near Surface (16.4 ft below surface)				Near Surface (16.4 ft below surface)				Within Thermocline (213.2 ft below surface)				Within Lower Isotherm (410 ft below surface)				Near Bottom (623.2 ft below surface)			
Analyte	Maximum Detected Conc. mg/L	CMC[1] mg/L	CCC[2] mg/L	Result mg/L	Qualifier	MDL	MRL[3]	Result mg/L	Qualifier	MDL	MRL[3]	Result mg/L	Qualifier	MDL	MRL[3]	Result mg/L	Qualifier	MDL	MRL[3]	Result mg/L	Qualifier	MDL	MRL[3]
Total Suspended Solids	13.0	x	x	8.5	–	5.0	5.0	7.5	–	5.0	5.0	6.0	–	5.0	5.0	13.0	–	5.0	5.0	7.0	–	5.0	5.0

[1] CMC = criteria maximum concentration (synonymous with 'acute'), see EPA (2006) or Buchman (2008) for definition. Values taken from EPA (2006) and/or Buchman (2008).

[2] CCC = criterion continuous concentration (synonymous with 'chronic'), see EPA (2006) or Buchman (2008) for definition. Values taken from EPA (2006) and/or Buchman (2008).

[3] MRL = method reporting limit, assigned by Columbia Analytical Services to a fixed factor above the method detection limit (MDL) depending on the analyte, unless otherwise specified.

– = no qualifier needed or no analysis performed for that analyte

x = no CMC or CCC published for parameter

Source: Columbia Analytical Services, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 8
Physical Analysis Summary of Sediment Samples Collected during the May 2011 Port Everglades Survey

Sample ID:	Inside ODMDS		Inside Expansion Areas		Outside Expansion Areas	
	PE11-1-SED	PE11-1-SED (Field Split)	PE11-2-SED	PE11-3-SED	PE11-4-SED	PE11-5-SED
Description	Greenish gray, very silty, clayey, medium to fine SAND	Greenish gray, very silty, clayey, medium to fine SAND	Greenish gray, very silty, clayey, medium to fine SAND	Greenish gray, very silty, clayey, medium to fine SAND	Greenish gray, very silty, clayey, medium to fine SAND	Greenish gray, very silty, clayey, medium to fine SAND
Percent Gravel[1]	0.0	0.0	0.0	0.0	0.0	0.0
Percent Coarse Sand[1]	0.3	0.4	1.0	0.2	0.5	0.5
Percent Medium Sand[1]	9.6	10.3	9.6	6.0	7.6	11.2
Percent Fine Sand[1]	55.2	52.8	54.3	49.5	50.2	51.9
Percent Sand (Coarse, Medium, & Fine Combined)	65.1	63.5	64.9	55.7	58.3	63.6
Percent Silt	22.8	23.7	23.0	28.9	26.7	23.9
Percent Clay	12.1	12.8	12.1	15.4	15.0	12.5
Percent Silt & Clay Combined[1]	34.9	36.5	35.1	44.3	41.7	36.4
Percent Total Solids	70.6	70.7	72.2	71.1	72.4	74.1
Percent Moisture (wet)	29.4	29.3	27.8	28.9	27.6	25.9
Unified Soil Classification System (USCS) Classes[3]	SC-SM	SC-SM	SC-SM	SC-SM	SC-SM	SC-SM
Metric						
Percent Passing Sieve Size[2] / **Metric Equivalent (mm)**	PE11-1-SED	PE11-1-SED (Field Split)	PE11-2-SED	PE11-3-SED	PE11-4-SED	PE11-5-SED
#4 / **4.75**	100.0	100.0	100.0	100.0	100.0	100.0
#10 / **2.00**	99.7	99.6	99.0	99.8	99.5	99.5
#20 / **0.85**	97.7	97.6	96.3	98.1	97.4	95.7
#40 / **0.425**	90.1	89.3	89.4	93.8	91.9	88.3
#60 / **0.250**	75.0	75.3	75.8	83.0	81.4	75.5
#140 / **0.104**	49.2	52.4	51.2	62.7	62.2	51.9
#200 / **0.075**	34.9	36.5	35.1	44.3	41.7	36.4
Hydrometer Readings (percent less than following sizes)	19.3 @ 0.0488 mm	20.6 @ 0.0484 mm	20.5 @ 0.0483 mm	28.4 @ 0.0466 mm	22.9 @ 0.0479 mm	20.8 @ 0.0481 mm
	18.0 @ 0.0347 mm	19.3 @ 0.0344 mm	19.2 @ 0.0344 mm	25.1 @ 0.0336 mm	21.5 @ 0.0341 mm	18.9 @ 0.0344 mm
	16.1 @ 0.0221 mm	17.3 @ 0.0220 mm	16.7 @ 0.0220 mm	21.9 @ 0.0215 mm	20.2 @ 0.0217 mm	18.3 @ 0.0218 mm
	14.7 @ 0.0129 mm	15.3 @ 0.0128 mm	15.5 @ 0.0128 mm	19.3 @ 0.0126 mm	17.6 @ 0.0127 mm	15.1 @ 0.0128 mm
	14.0 @ 0.0091 mm	14.0 @ 0.0091 mm	14.2 @ 0.0091 mm	17.3 @ 0.0090 mm	16.9 @ 0.0090 mm	14.4 @ 0.0091 mm
	12.8 @ 0.0065 mm	13.3 @ 0.0065 mm	12.9 @ 0.0065 mm	15.9 @ 0.0064 mm	15.6 @ 0.0064 mm	13.2 @ 0.0065 mm
	11.4 @ 0.0032 mm	11.9 @ 0.0032 mm	11.0 @ 0.0032 mm	14.6 @ 0.0032 mm	14.3 @ 0.0032 mm	11.9 @ 0.0032 mm
	10.0 @ 0.0013 mm	10.4 @ 0.0013 mm	10.3 @ 0.0013 mm	11.2 @ 0.0013 mm	11.5 @ 0.0013 mm	10.5 @ 0.0013 mm

[1] Particle sizes: Gravel = particles ≥4.750 mm, Sand = particles ≥0.075 mm and <4.750 mm, and Silt/Clay = particles <0.075 mm.

[2] Both ASTM D 422 and ASTM D-1140 methods were used in this study; see Appendix F for grain size distribution graphs.

[3] USCS classifications: SC = clayey sand, SM = silty sands

Source: MACTEC Engineering and Consulting, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 9
Results of Dry Weight Metals, TOC, and Organotins in Sediment Collected during the May 2011 Port Everglades Survey

					Inside ODMDS								Inside Expansion Areas								Outside Expansion Areas							
				Sample ID:	PE11-1-SED				PE11-1-SED (Field Split)				PE11-2-SED				PE11-3-SED				PE11-4-SED				PE11-5-SED			
Analyte	Maximum Detected Conc. (mg/kg)	TEL[1] mg/kg	ERL[2] mg/kg	AET[3] mg/kg	Result mg/kg	Qualifier	MDL	MRL[4]	Result mg/kg	Qualifier	MDL	MRL[4]	Result mg/kg	Qualifier	MDL	MRL[4]	Result mg/kg	Qualifier	MDL	MRL[4]	Result mg/kg	Qualifier	MDL	MRL[4]	Result mg/kg	Qualifier	MDL	MRL[4]
Arsenic	2.41	7.24	8.2	35	1.95	–	0.03	0.34	2.12	–	0.04	0.36	1.62	–	0.03	0.34	2.41	–	0.04	0.36	2.34	–	0.03	0.34	1.66	–	0.03	0.33
Cadmium	0.092	0.676	1.2	3	0.062	–	0.003	0.014	0.063	–	0.003	0.015	0.075	–	0.003	0.013	0.092	–	0.003	0.014	0.088	–	0.003	0.014	0.082	–	0.003	0.013
Chromium	13.2	52.3	81	62	10.7	–	0.02	0.14	11.1	–	0.02	0.15	10.7	–	0.02	0.13	12.4	–	0.02	0.14	13.2	–	0.02	0.14	10.7	–	0.02	0.13
Copper	8.23	18.7	34	390	8.23	*	0.06	0.07	4.38	*	0.06	0.07	2.24	*	0.05	0.07	2.70	*	0.06	0.07	2.69	*	0.05	0.07	2.38	*	0.05	0.07
Lead	5.660	30.24	46.7	400	5.660	*	0.004	0.034	3.490	*	0.004	0.036	1.720	*	0.004	0.034	2.080	*	0.004	0.036	2.130	*	0.004	0.034	1.520	*	0.004	0.033
Mercury	0.026	0.13	0.15	0.41	0.022	–	0.002	0.019	0.026	–	0.002	0.020	0.014	J	0.002	0.020	0.020	–	0.002	0.020	0.022	–	0.002	0.019	0.015	J	0.002	0.019
Nickel	13.6	15.9	20.9	110	8.30	–	0.01	0.14	9.45	–	0.02	0.15	10.1	–	0.01	0.13	13.6	–	0.01	0.14	13.1	–	0.01	0.14	12.1	–	0.01	0.13
Selenium	0.25	x	x	1	0.13	–	0.02	0.07	0.15	–	0.02	0.08	0.17	–	0.02	0.07	0.25	–	0.02	0.06	0.23	–	0.02	0.07	0.22	–	0.02	0.06
Silver	0.017	0.73	1	3.1	0.015	J	0.006	0.015	0.017	–	0.006	0.015	0.012	J	0.006	0.015	0.012	J	0.006	0.015	0.012	J	0.005	0.013	0.007	J	0.006	0.014
Zinc	6.8	124	150	410	6.8	–	0.1	0.3	6.5	–	0.1	0.4	3.9	–	0.1	0.3	4.3	–	0.1	0.4	4.3	–	0.1	0.3	3.8	–	0.1	0.3
Analyte	**Maximum Detected Conc. (%)**	**TEL[1]**	**ERL[2]**	**AET[3]**	**Result (%)**	**Qualifier**	**MDL**	**MRL[4]**	**Result (%)**	**Qualifier**	**MDL**	**MRL[4]**	**Result (%)**	**Qualifier**	**MDL**	**MRL[4]**	**Result (%)**	**Qualifier**	**MDL**	**MRL[4]**	**Result (%)**	**Qualifier**	**MDL**	**MRL[4]**	**Result (%)**	**Qualifier**	**MDL**	**MRL[4]**
Carbon, Total Organic	0.868	x	x	x	0.387	–	0.020	0.050	0.680	–	0.020	0.050	0.309	–	0.020	0.050	0.868	–	0.020	0.050	0.238	–	0.020	0.050	0.769	–	0.020	0.050
Analyte	**Maximum Detected Conc. (µg/kg)**	**TEL[1]**	**ERL[2]**	**AET[3]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[4]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[4]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[4]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[4]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[4]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[4]**
Tri-n-butyltin Cation	24	x	x	x	24	–	0.64	1.5	18	–	0.63	1.5	0.81	J	0.64	1.5	ND	U	0.64	1.5	ND	U	0.63	1.5	ND	U	0.61	1.5
Di-n-butyltin Cation	3.3	x	x	x	2.7	–	0.29	1.5	3.3	–	0.28	1.5	ND	U	0.28	1.5	ND	U	0.29	1.5	ND	U	0.28	1.5	ND	U	0.27	1.5
n-Butyltin Cation	3.1	x	x	x	3.1	–	0.39	1.5	2.5	–	0.38	1.5	ND	U	0.39	1.5	ND	U	0.39	1.5	ND	U	0.38	1.5	0.39	J	0.37	1.5
Total Organotins (as Sn)	13	x	x	x	13	–	–	–	11	–	–	–	0.74	–	–	–	0.67	–	–	–	0.66	–	–	–	0.65	–	–	–

[1] TEL = threshold effects level, see Section 3.2.2 for definition.

[2] ERL = effects range-low, see Section 3.2.2 for definition.

[3] AET = apparent effects threshold, see Section 3.2.2 for definition.

[4] MRL = method reporting limit, assigned by Columbia Analytical Services to a fixed factor above the method detection limit (MDL) depending on the analyte, unless otherwise specified.

J = the result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

ND = not detected at or above the method detection limit (MDL).

U = the compound was analyzed for but not detected at or above the MDL.

x = no TEL, ERL, and/or AET published for parameter.

– = no qualifier needed or no analysis performed for that analyte.

* = the result is an outlier. The relative percent difference for the replicate analysis was outside the normal CAS control limits (30%) due to the heterogeneity of the sample. See Section 5.3 for more information.

Source: Columbia Analytical Services, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 10
Results of Dry Weight Organochlorine Pesticide Analysis of Sediment Collected during the May 2011 Port Everglades Survey

					Inside ODMDS								Inside Expansion Areas								Outside Expansion Areas							
				Sample ID:	PE11-1-SED				PE11-1-SED (Field Split)				PE11-2-SED				PE11-3-SED				PE11-4-SED				PE11-5-SED			
Analyte	Maximum Detected Conc. µg/kg	TEL[1] µg/kg	ERL[2] µg/kg	AET[3] µg/kg	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]
Aldrin	ND	x	x	9.5	ND	U	0.16	0.74	ND	U	0.16	0.74	ND	U	0.16	0.74	ND	U	0.16	0.75	ND	U	0.16	0.74	ND	U	0.16	0.72
Chlordane & Derivatives																												
Technical Chlordane	ND	2.26	0.5	0.28	ND	U	1.9	7.4	ND	U	1.9	7.4	ND	U	1.9	7.4	ND	U	1.9	7.5	ND	U	1.9	7.4	ND	U,i	2.2	7.2
α (cis)-Chlordane	ND	x	x	x	ND	U	0.10	0.74	ND	U	0.10	0.74	ND	U	0.10	0.74	ND	U	0.10	0.75	ND	U	0.10	0.74	ND	U,i	0.21	0.72
γ (trans)-Chlordane	0.10	x	x	x	ND	U	0.090	0.74	0.10	J	0.090	0.74	ND	U	0.090	0.74	ND	U	0.090	0.75	ND	U	0.090	0.74	ND	U	0.090	0.72
cis-Nonachlor	ND	x	x	x	ND	U,i	0.74	0.74	ND	U	0.12	0.74	ND	U	0.12	0.74	ND	U	0.12	0.75	ND	U	0.12	0.74	ND	U	0.12	0.72
Oxychlordane	ND	x	x	x	ND	U	0.085	0.74	ND	U	0.085	0.74	ND	U	0.085	0.74	ND	U	0.085	0.75	ND	U	0.085	0.74	ND	U,i	0.21	0.72
trans-Nonachlor	ND	x	x	x	ND	U,i	0.74	0.74	ND	U	0.087	0.74	ND	U	0.087	0.74	ND	U	0.087	0.75	ND	U	0.087	0.74	ND	U	0.087	0.72
DDT & Derivatives																												
p,p' (4,4')-DDD	**160**	1.22	2	16	**160**	D	2.2	15	ND	U,i	0.33	0.74	ND	U	0.11	0.74	ND	U	0.11	0.75	ND	U	0.11	0.74	ND	U	0.11	0.72
p,p' (4,4')-DDE	0.27	2.07	2.2	9	ND	U,i	0.74	0.74	0.27	J	0.11	0.74	ND	U	0.11	0.74	ND	U	0.11	0.75	ND	U,i	0.13	0.74	ND	U,i	0.66	0.72
p,p' (4,4')-DDT	0.45	1.19	1	12	0.45	J,P	0.17	0.74	0.31	J	0.17	0.74	ND	U	0.17	0.74	ND	U	0.17	0.75	ND	U	0.17	0.74	ND	U	0.17	0.72
Dieldrin	ND	0.715	0.02	1.9	ND	U	0.14	0.74	ND	U	0.14	0.74	ND	U	0.14	0.74	ND	U	0.14	0.75	ND	U	0.14	0.74	ND	U	0.14	0.72
Endosulfan & Derivatives																												
Endosulfan I	ND	x	x	x	ND	U,i	0.14	0.74	ND	U	0.063	0.74	ND	U	0.063	0.74	ND	U	0.063	0.75	ND	U	0.063	0.74	ND	U	0.063	0.72
Endosulfan II	ND	x	x	x	ND	U	0.14	0.74	ND	U	0.14	0.74	ND	U	0.14	0.74	ND	U	0.14	0.75	ND	U	0.14	0.74	ND	U	0.14	0.72
Endrin & Derivatives																												
Endrin	ND	x	x	x	ND	U	0.094	0.74	ND	U	0.094	0.74	ND	U	0.094	0.74	ND	U	0.094	0.75	ND	U	0.094	0.74	ND	U	0.094	0.72
Endrin Aldehyde	ND	x	x	x	ND	U	0.12	0.74	ND	U	0.12	0.74	ND	U	0.12	0.74	ND	U	0.12	0.75	ND	U	0.12	0.74	ND	U	0.12	0.72
Endrin Ketone	ND	x	x	x	ND	U	0.093	0.74	ND	U	0.093	0.74	ND	U	0.093	0.74	ND	U	0.093	0.75	ND	U	0.093	0.74	ND	U	0.093	0.72
Heptachlor & Derivatives																												
Heptachlor	ND	x	x	0.3	ND	U	0.12	0.74	ND	U	0.12	0.74	ND	U	0.12	0.74	ND	U	0.12	0.75	ND	U	0.12	0.74	ND	U	0.12	0.72
Heptachlor Epoxide	ND	x	x	x	ND	U	0.084	0.74	ND	U,i	0.11	0.74	ND	U	0.084	0.74	ND	U	0.084	0.75	ND	U	0.084	0.74	ND	U	0.084	0.72
Hexachlorocyclohexane (BHC)																												
α-BHC	ND	x	x	x	ND	U	0.11	0.74	ND	U	0.11	0.74	ND	U	0.11	0.74	ND	U	0.11	0.75	ND	U	0.11	0.74	ND	U	0.11	0.72
β-BHC	ND	x	x	x	ND	U	0.18	0.74	ND	U	0.18	0.74	ND	U	0.18	0.74	ND	U	0.18	0.75	ND	U	0.18	0.74	ND	U	0.18	0.72
γ-BHC (Lindane)	ND	0.32	x	4.8	ND	U	0.080	0.74	ND	U	0.080	0.74	ND	U	0.080	0.74	ND	U	0.080	0.75	ND	U	0.080	0.74	ND	U	0.080	0.72
δ-BHC	ND	x	x	x	ND	U	0.074	0.74	ND	U	0.074	0.74	ND	U	0.074	0.74	ND	U	0.074	0.75	ND	U	0.074	0.74	ND	U	0.074	0.72
Methoxychlor	ND	x	x	x	ND	U	0.19	0.74	ND	U,i	0.20	0.74	ND	U	0.19	0.74	ND	U	0.19	0.75	ND	U	0.19	0.74	ND	U	0.19	0.72
Mirex®	ND	x	x	x	ND	U	0.099	0.74	ND	U	0.099	0.74	ND	U	0.099	0.74	ND	U	0.099	0.75	ND	U	0.099	0.74	ND	U	0.099	0.72
Toxaphene	ND	0.1	x	x	ND	U,i	6.0	37	ND	U,i	9.2	37	ND	U,i	6.2	37	ND	U	4.8	38	ND	U	4.8	37	ND	U	4.8	36

[1] TEL = threshold effects level, see Section 3.2.2 for definition.
[2] ERL = effects range-low, see Section 3.2.2 for definition.
[3] AET = apparent effects threshold, see Section 3.2.2 for definition.
[4] MRL = method reporting limit is defined as the lowest instrument calibration standard.
D = the reported result is from a dilution.
i = the MRL/MDL has been elevated due to a chromatographic interference.
P = the GC or HPLC confirmaton criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results (25% for CLP Pesticides).
J = the result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
U = the compound was analyzed for but not detected at or above the MDL.
ND = not detected at or above the method detection limit (MDL).
x = no TEL, ERL, and/or AET published for parameter.
Numbers in bold denote a value greater than or equal to the TEL, ERL, and/or AET.

Source: Columbia Analytical Services, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 11
Results of Dry Weight PAH Analyses of Sediment Collected during the May 2011 Port Everglades Survey

					Inside ODMDS								Inside Expansion Areas								Outside Expansion Areas							
				Sample ID:	PE11-1-SED				PE11-1-SED (Field Split)				PE11-2-SED				PE11-3-SED				PE11-4-SED				PE11-5-SED			
Analyte	Maximum Detected Conc. µg/kg	TEL[1] µg/kg	ERL[2] µg/kg	AET[3] µg/kg	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]
1-Methylnaphthalene[LMW]	1.1	x	x	x	1.1	J	0.51	3.7	ND	U	0.51	3.8	ND	U	0.51	3.7	ND	U	0.51	3.8	ND	U	0.51	3.7	ND	U	0.51	3.6
2-Methylnaphthalene[LMW]	1.5	20.21	70	64	1.5	J	0.46	3.7	0.66	J	0.46	3.8	ND	U	0.46	3.7	ND	U	0.46	3.8	ND	U	0.46	3.7	ND	U	0.46	3.6
Acenaphthene[LMW]	**8.8**	6.71	16	130	**8.8**	–	0.76	3.7	ND	U	0.76	3.8	ND	U	0.76	3.7	ND	U	0.76	3.8	ND	U	0.76	3.7	ND	U	0.76	3.6
Acenaphthylene	1.7	5.87	44	71	0.63	J	0.59	3.7	1.7	J	0.59	3.8	ND	U	0.59	3.7	ND	U	0.59	3.8	ND	U	0.59	3.7	ND	U	0.59	3.6
Anthracene[LMW]	20	46.85	85.3	280	20	–	0.58	3.7	2.5	J	0.58	3.8	ND	U	0.58	3.7	ND	U	0.58	3.8	ND	U	0.58	3.7	ND	U	0.58	3.6
Benzo(a)anthracene[HMW]	51	74.83	261	960	51	–	0.72	3.7	20	–	0.72	3.8	0.78	J	0.72	3.7	1.1	J	0.72	3.8	0.89	J	0.72	3.7	0.76	J	0.72	3.6
Benzo(a)pyrene[HMW]	44	88.81	430	1100	44	–	0.76	3.7	20	–	0.76	3.8	ND	U	0.76	3.7	ND	U	0.76	3.8	ND	U	0.76	3.7	ND	U	0.76	3.6
Benzo(b)fluoranthene	72	x	x	1800	72	–	0.92	3.7	37	–	0.92	3.8	1.3	J	0.92	3.7	1.4	J	0.92	3.8	1.3	J	0.92	3.7	1.1	J	0.92	3.6
Benzo(g,h,i)perylene	34	x	x	670	34	–	0.85	3.7	12	–	0.85	3.8	ND	U	0.85	3.7	0.87	J	0.85	3.8	ND	U	0.85	3.7	ND	U	0.85	3.6
Benzo(k)fluoranthene	25	x	x	1800	25	–	0.87	3.7	13	–	0.87	3.8	ND	U	0.87	3.7	ND	U	0.87	3.8	ND	U	0.87	3.7	ND	U	0.87	3.6
Chrysene[HMW]	54	107.77	384	950	54	–	0.80	3.7	19	–	0.80	3.8	ND	U	0.80	3.7	ND	U	0.80	3.8	0.92	J	0.80	3.7	1.3	J	0.80	3.6
Dibenzo(a,h)anthracene[HMW]	**6.5**	6.22	63.4	230	**6.5**	–	0.80	3.7	2.4	J	0.80	3.8	ND	U	0.80	3.7	ND	U	0.80	3.8	ND	U	0.80	3.7	ND	U	0.80	3.6
Fluoranthene[HMW]	**120**	112.82	600	1300	**120**	–	0.98	3.7	23	–	0.98	3.8	1.2	J	0.98	3.7	1.2	J	0.98	3.8	1.3	J	0.98	3.7	1.3	J	0.98	3.6
Fluorene[LMW]	11	21.17	19	120	11	–	0.61	3.7	0.84	J	0.61	3.8	ND	U	0.61	3.7	ND	U	0.61	3.8	ND	U	0.61	3.7	ND	U	0.61	3.6
Indeno(1,2,3-cd)pyrene	34	x	x	600	34	–	0.87	3.7	12	–	0.87	3.8	ND	U	0.87	3.7	ND	U	0.87	3.8	ND	U	0.87	3.7	ND	U	0.87	3.6
Naphthalene[LMW]	2.4	34.57	160	230	2.4	J	0.60	3.7	0.74	J	0.60	3.8	ND	U	0.60	3.7	ND	U	0.60	3.8	ND	U	0.60	3.7	ND	U	0.60	3.6
Phenanthrene[LMW]	**100**	86.68	240	660	**100**	–	1.4	3.7	7.2	–	1.4	3.8	ND	U	1.4	3.7	ND	U	1.4	3.8	ND	U	1.4	3.7	ND	U	1.4	3.6
Pyrene[HMW]	91	152.66	665	2400	91	–	0.76	3.7	25	–	0.76	3.8	1.2	J	0.76	3.7	1.4	J	0.76	3.8	1.3	J	0.76	3.7	1.2	J	0.76	3.6
Total LMW PAHs[5]	145	312	552	1200	145	–	–	–	13.2	–	–	–	4.9	–	–	–	4.9	–	–	–	4.9	–	–	–	4.9	–	–	–
Total HMW PAHs[5]	367	655	1700	7900	367	–	–	–	109	–	–	–	5.5	–	–	–	6.1	–	–	–	6.0	–	–	–	6.1	–	–	–
Total PAHs[5]	677	1684	4022	x	677	–	–	–	198	–	–	–	14.9	–	–	–	15.6	–	–	–	15.4	–	–	–	15.3	–	–	–

[1] TEL = threshold effects level, see Section 3.2.2 for definition.
[2] ERL = effects range-low, see Section 3.2.2 for definition.
[3] AET = apparent effects threshold, see Section 3.2.2 for definition.
[4] MRL = method reporting limit is defined as the lowest instrument calibration standard.
[5] U-qualified data calculated as the method detection limit (MDL).
[LMW] Low molecular weight PAHs (NOAA 1989).
[HMW] High molecular weight PAHs (NOAA 1989).

Source: Columbia Analytical Services, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

J = the result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
U = the compound was analyzed for but not detected at or above the MDL.
ND = not detected at or above the MDL.
x = no TEL, ERL, and/or AET published for parameter.
Numbers in bold denote a value greater than or equal to the TEL, ERL, and/or AET.
– = no qualifier needed or no analysis performed for that analyte.

TABLE 12
Results of Dry Weight PCB Analyses of Sediment Collected during the May 2011 Port Everglades Survey

ANAMAR Environmental Consulting, Inc.

					Inside ODMDS								Inside Expansion Areas								Outside Expansion Areas							
				Sample ID:	PE11-1-SED				PE11-1-SED (Field Split)				PE11-2-SED				PE11-3-SED				PE11-4-SED				PE11-5-SED			
Analyte	Maximum Detected Conc. (µg/kg)	TEL[1] µg/kg	ERL[2] µg/kg	AET[3] µg/kg	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]	Result µg/kg	Qualifier	MDL	MRL[4]
PCB 8[NOAA]	ND	x	x	x	ND	U	0.21	0.37	ND	U	0.21	0.37	ND	U	0.21	0.37	ND	U	0.21	0.38	ND	U	0.21	0.37	ND	U	0.21	0.36
PCB 18[NOAA]	ND	x	x	x	ND	U	0.096	0.37	ND	U,i	0.14	0.37	ND	U	0.096	0.37	ND	U	0.096	0.38	ND	U	0.096	0.37	ND	U	0.096	0.36
PCB 28[NOAA]	0.079	x	x	x	0.079	J	0.064	0.37	ND	U,i	0.093	0.37	ND	U	0.064	0.37	ND	U	0.064	0.38	ND	U	0.064	0.37	ND	U	0.064	0.36
PCB 44[NOAA]	0.080	x	x	x	0.077	J	0.065	0.37	0.080	J	0.065	0.37	ND	U	0.065	0.37	ND	U	0.065	0.38	ND	U	0.065	0.37	ND	U	0.065	0.36
PCB 49	0.13	x	x	x	0.13	J,P	0.058	0.37	ND	U,i	0.25	0.37	ND	U	0.058	0.37	ND	U	0.058	0.38	ND	U	0.058	0.37	ND	U	0.058	0.36
PCB 52[NOAA]	0.17	x	x	x	0.17	J	0.059	0.37	ND	U,i	0.29	0.37	ND	U	0.059	0.37	ND	U	0.059	0.38	ND	U	0.059	0.37	ND	U	0.059	0.36
PCB 66[NOAA]	0.13	x	x	x	0.13	J	0.035	0.37	ND	U,i	0.19	0.37	ND	U	0.035	0.37	ND	U	0.035	0.38	ND	U	0.035	0.37	ND	U	0.035	0.36
PCB 77	ND	x	x	x	ND	Ui	0.37	0.37	ND	U	0.047	0.37	ND	U	0.047	0.37	ND	U	0.047	0.38	ND	U	0.047	0.37	ND	U	0.047	0.36
PCB 87	ND	x	x	x	ND	U,i	0.37	0.37	ND	U	0.038	0.37	ND	U	0.038	0.37	ND	U	0.038	0.38	ND	U	0.038	0.37	ND	U	0.038	0.36
PCB 101[NOAA]	0.30	x	x	x	ND	U,i	0.37	0.37	0.30	J	0.049	0.37	ND	U	0.049	0.37	ND	U	0.049	0.38	ND	U	0.049	0.37	ND	U	0.049	0.36
PCB 105[NOAA]	0.046	x	x	x	0.037	J	0.033	0.37	0.046	J	0.033	0.37	ND	U	0.033	0.37	ND	U	0.033	0.38	ND	U	0.033	0.37	ND	U	0.033	0.36
PCB 118[NOAA]	0.22	x	x	x	0.11	J	0.031	0.37	0.22	J	0.031	0.37	ND	U	0.031	0.37	ND	U	0.031	0.38	ND	U	0.031	0.37	ND	U	0.031	0.36
PCB 126	ND	x	x	x	ND	U	0.043	0.37	ND	U	0.043	0.37	ND	U	0.043	0.37	ND	U	0.043	0.38	ND	U	0.043	0.37	ND	U	0.043	0.36
PCB 128[NOAA]	0.060	x	x	x	ND	U,i	0.045	0.37	0.060	J	0.031	0.37	ND	U	0.031	0.37	ND	U	0.031	0.38	ND	U	0.031	0.37	ND	U	0.031	0.36
PCB 138[NOAA]	0.26	x	x	x	0.19	J	0.064	0.37	0.26	J	0.064	0.37	ND	U	0.064	0.37	ND	U	0.064	0.38	ND	U	0.064	0.37	ND	U	0.064	0.36
PCB 153[NOAA]	0.14	x	x	x	ND	U	0.038	0.37	0.14	J,P	0.038	0.37	ND	U	0.038	0.37	ND	U	0.038	0.38	ND	U	0.038	0.37	ND	U	0.038	0.36
PCB 156	ND	x	x	x	ND	U	0.042	0.37	ND	U	0.042	0.37	ND	U	0.042	0.37	ND	U	0.042	0.38	ND	U	0.042	0.37	ND	U	0.042	0.36
PCB 169	ND	x	x	x	ND	U	0.041	0.37	ND	U	0.041	0.37	ND	U	0.041	0.37	ND	U	0.041	0.38	ND	U	0.041	0.37	ND	U	0.041	0.36
PCB 170[NOAA]	0.070	x	x	x	0.036	J,P	0.026	0.37	0.070	J	0.026	0.37	ND	U	0.026	0.37	ND	U	0.026	0.38	ND	U	0.026	0.37	ND	U	0.026	0.36
PCB 180[NOAA]	0.15	x	x	x	ND	U	0.095	0.37	0.15	J	0.095	0.37	ND	U	0.095	0.37	ND	U	0.095	0.38	ND	U	0.095	0.37	ND	U	0.095	0.36
PCB 183	ND	x	x	x	ND	U	0.081	0.37	ND	U,i	0.37	0.37	ND	U,i	0.37	0.37	ND	U	0.081	0.38	ND	U	0.081	0.37	ND	U	0.081	0.36
PCB 184	ND	x	x	x	ND	U	0.052	0.37	ND	U	0.052	0.37	ND	U	0.052	0.37	ND	U	0.052	0.38	ND	U	0.052	0.37	ND	U	0.052	0.36
PCB 187[NOAA]	0.10	x	x	x	ND	U	0.047	0.37	0.10	J	0.047	0.37	ND	U	0.047	0.37	ND	U	0.047	0.38	ND	U	0.047	0.37	ND	U	0.047	0.36
PCB 195[NOAA]	ND	x	x	x	ND	U	0.031	0.37	ND	U	0.031	0.37	ND	U	0.031	0.37	ND	U	0.031	0.38	ND	U	0.031	0.37	ND	U	0.031	0.36
PCB 206[NOAA]	ND	x	x	x	ND	U,i	0.045	0.37	ND	U	0.031	0.37	ND	U	0.031	0.37	ND	U	0.031	0.38	ND	U	0.031	0.37	ND	U	0.031	0.36
PCB 209[NOAA]	ND	x	x	x	ND	U,i	0.37	0.37	ND	U	0.041	0.37	ND	U	0.041	0.37	ND	U	0.041	0.38	ND	U	0.041	0.37	ND	U	0.041	0.36
Total EPA Region 4 PCBs[5]	3.34	21.6	22.7	x	2.94	–	–	–	3.34	–	–	–	1.74	–	–	–	1.45	–	–	–	1.45	–	–	–	1.45	–	–	–
Total NOAA PCBs[6]	4.90	21.6	22.7	x	4.35	–	–	–	4.90	–	–	–	2.09	–	–	–	2.09	–	–	–	2.09	–	–	–	2.09	–	–	–

[1] TEL = threshold effects level, see Section 3.2.2 for definition.
[2] ERL = effects range-low, see Section 3.2.2 for definition.
[3] AET = apparent effects threshold, see Section 3.2.2 for definition.
[4] MRL = method reporting limit is defined as the lowest instrument calibration standard.
[5] Total EPA Region 4 PCBs, see SERIM Section 7.3. U-qualified data calculated as the MDL.
[6] Total NOAA PCBs, see SERIM Section 7.3 for details. U-qualified data calculated as the MDL.
[NOAA] National Oceanic and Atmospheric Administration PCB cogeners.
P = the GC or HPLC confirmaton criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results (25% for CLP Pesticides).

– = no qualifier needed.
i = the MDL has been elevated due to chromatographic interference.
J = the result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
ND = not detected at or above the MDL.
x = no TEL, ERL, and/or AET published for parameter.
U = the compound was analyzed for but not detected at or above the MDL.

Source: Columbia Analytical Services, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 13
Invertebrate and Fish Biomass per Trawl Captured during the May 2011 Port Everglades Survey

Station Number	Inside Expansion Areas				Outside Expansion Areas				Mean of Trawl Samples	Mean of Day Trawl Samples	Mean of Night Trawl Samples	Range of Trawl Samples
	PE11-6		PE11-7		PE11-8		PE11-9					
Abbreviated Sample ID	A	B	A	B	A	B	A	B				
Day or Night Trawl:	Day	Night	Night	Day	Day	Night	Day	Night				
Invertebrate Wet Weight Biomass[1] (kg)	1.10	1.70	0.70	1.50	0.55	0.70	2.10	7.00	1.92	1.31	2.53	0.55 – 7.00
Fish Wet Weight Biomass (kg)	1.10	1.20	0.00	0.05	0.35	0.05	0.65	4.55	0.99	0.54	1.45	0.00 – 4.55
Total Wet Weight Biomass (kg)	2.20	2.90	0.70	1.55	0.90	0.75	2.75	11.55	2.91	1.85	3.98	0.70 – 11.55
Estimated Surface Area Sampled[2] (m^2)	3,415	3,740	4,579	5,004	5,365	5,349	4,151	6,010	4,702	4,484	4,920	3,415 – 6,010
Invertebrate Wet Weight Biomass (kg) per 1,000 m^2	**0.32**	**0.45**	**0.15**	**0.30**	**0.10**	**0.13**	**0.51**	**1.16**	**0.39**	**0.31**	**0.48**	**0.10 – 1.16**
Fish Wet Weight Biomass (kg) per 1,000 m^2	**0.32**	**0.32**	**0.00**	**0.01**	**0.07**	**0.01**	**0.16**	**0.76**	**0.21**	**0.14**	**0.27**	**0.00 – 0.76**
Total Wet Weight Biomass (kg) per 1,000 m^2	**0.64**	**0.78**	**0.15**	**0.31**	**0.17**	**0.14**	**0.66**	**1.92**	**0.60**	**0.45**	**0.75**	**0.14 – 1.92**

[1] Invertebrate wet weight biomass did not include disarticulated arms of the *Coronaster briareus* sea star.

[2] Estimated surface area sampled was calculated by multiplying the length of tow (nmi) by 1,852 (meters per nmi) and multiplying the product by 7.317 (width of trawl in meters).

Source: ANAMAR Environmental Consulting, Inc.

TABLE 14

Invertebrate and Fish Biomass per Station Captured by Trawl during the May 2011 Port Everglades Survey

Station Number	Inside Expansion Areas		Outside Expansion Areas		Mean of Stations	Range of Stations
	PE11-6	PE11-7	PE11-8	PE11-9		
Invertebrate Wet Weight Biomass[1] (kg)	2.80	2.20	1.25	9.10	3.84	1.25 – 9.10
Fish Wet Weight Biomass (kg)	2.30	0.05	0.40	5.20	1.99	0.05 – 5.20
Total Wet Weight Biomass (kg)	5.10	2.25	1.65	14.30	5.83	1.65 – 14.30
Estimated Surface Area Sampled[2] (m^2)	7,155	9,583	10,714	10,161	9,403	7,155 – 10,714
Invertebrate Wet Weight Biomass (kg) per 1,000 m^2	**0.39**	**0.23**	**0.12**	**0.90**	**0.41**	**0.12 – 0.90**
Fish Wet Weight Biomass (kg) per 1,000 m^2	**0.32**	**0.01**	**0.04**	**0.51**	**0.22**	**0.01 – 0.51**
Total Wet Weight Biomass (kg) per 1,000 m^2	**0.71**	**0.23**	**0.15**	**1.41**	**0.63**	**0.15 – 1.41**

[1] Invertebrate wet weight biomass did not include disarticulated arms of the *Coronaster briareus* sea star.

[2] Estimated surface area sampled was calculated by multiplying the length of tow (nmi) by 1852 (meters per nmi) and multiplying the product by 7.317 (width of trawl in meters).

Source: ANAMAR Environmental Consulting, Inc.

TABLE 15
Invertebrate and Fish Biomass in Relation to the Expansion Areas Captured by Trawl during the May 2011 Port Everglades Survey

Pooled Station Numbers	Inside Expansion Areas PE11-6 & PE11-7	Outside Expansion Areas PE11-8 & PE11-9	Mean of Inside and Outside Areas	Range of Inside and Outside Areas
Invertebrate Wet Weight Biomass[1] (kg)	5.00	10.35	7.68	5.00 – 10.35
Fish Wet Weight Biomass (kg)	2.35	5.60	3.98	2.35 – 5.60
Total Epifaunal Wet Weight Biomass (kg)	7.35	15.95	11.65	7.35 – 15.95
Total Estimated Surface Area Sampled[2] (m^2)	16,738	20,875	18,807	16,738 – 20,875
Invertebrate Wet Weight Biomass (kg) per 1,000 m^2	**0.30**	**0.50**	**0.40**	**0.30 – 0.50**
Fish Wet Weight Biomass (kg) per 1,000 m^2	**0.14**	**0.27**	**0.20**	**0.14 – 0.27**
Total Wet Weight Biomass (kg) per 1,000 m^2	**0.44**	**0.76**	**0.60**	**0.44 – 0.76**

[1] Invertebrate wet weight biomass did not include disarticulated arms of *Coronaster briareus* sea stars.

[2] Estimated surface area sampled was calculated by multiplying the length of tow (nmi) by 1852 (meters per nmi) and multiplying the result by 7.317 (width of trawl in meters).

Source: ANAMAR Environmental Consulting, Inc.

TABLE 16
Phylogenetic List of Invertebrates Captured by Trawl during the May 2011 Port Everglades Survey

Phylum[1]	Subphylum	Class	Order	Family or Larger Group	Genus or Species[2]	Common Name[3]	When Collected: Day	When Collected: Night	Inside or Outside Expansion Areas: Inside	Inside or Outside Expansion Areas: Outside
Cnidaria										
		Scyphozoa				(true jellyfish)	✓	✓	✓	✓
		Hydrozoa: Hydroidolina				(hydroids)	✓	✓	✓	✓
					Species A (feathery)		✓	✓	✓	
					Species B (branching)		✓	✓	✓	
		Anthozoa								
			Alcyonacea			(true soft corals)	✓	✓	✓	✓
			Actiniaria			(sea anemones)	✓	✓	✓	✓
Mollusca										
		Bivalvia								
			Mytiloida							
				Mytilidae						
					Amygdalum sagittatum	arrow papermussel	✓			✓
			Veneroida							
				Cardiidae						
					Nemocardium peramabile	lovely micro-cockle		✓		✓
			Pholadomyoida							
				Poromyidae						
					Poromya granulata	granular poromya		✓		✓
				Verticordiidae						
					Verticordia acuticostata	sharp-ribbed verticord		✓	✓	
				Cuspidariidae						
					Cuspidaria rostrata	rostrate dipperclam	✓	✓		✓
		Cephalopoda								
			Sepiolida							
				Sepiolidae						
					Semirossia tenera	lesser bobtail squid	✓			✓
Sipuncula						(sipunculid worms)	✓			✓
Annelida										
		Polychaeta				(polychaete worms)	✓	✓	✓	✓
			Canalipalpata							
				Sabellidae		(feather duster worms)	✓		✓	
				Terebellidae		(terebelid worms)	✓		✓	
			Capitellidae							
				Maldanidae		(bamboo worms)		✓		✓
Arthropoda										
		Pycnogonida				sea spiders		✓	✓	
	Crustacea									
		Malacostraca								
			Decapoda							
				Solenoceridae		(solenocerid shrimps)		✓		✓
					Solenocera sp.	(an solenocerid shrimp genus)		✓		✓
				Pandalidae		(pandalid shrimps)	✓	✓	✓	✓
				Crangonidae		(argid shrimps)		✓		✓
					Pontophilus sp.	(an argid shrimp genus)	✓	✓	✓	
				Nephropidae						
					Nephropsis sp.	(lobsterette)		✓	✓	✓
				Diogenidae		(left-handed hermit crabs)	✓	✓	✓	✓
				Paguridae		(right-handed hermit crabs)	✓	✓	✓	✓
				Galatheidae						
					Agononida longipes	(a squat lobster)	✓	✓	✓	✓
					Munida iris	(a squat lobster)	✓	✓	✓	✓
				Majidae		(spider crabs)	✓	✓	✓	✓
					Pyromaia cuspidata	dartnose pear crab	✓	✓		✓
				Cancridae						
					Cancer borealis	Jonah crab	✓	✓	✓	✓
				Portunidae						
					Bathynectes longispina	bathyal swimming crab	✓	✓	✓	✓
				Pilumnidae		(hairy crabs)	✓		✓	
				Goneplacidae						
					Trizocarcinus tacitus	(a bathyal crab)		✓	✓	
				Brachyura		(a crab infraorder)	✓			✓
		Maxillopoda								
			Sessilia							
				Verrucidae		(wart barnacles)	✓		✓	✓
Echinodermata										
	Asterozoa									
		Asteroidea					✓			✓
			Forcipulatida							
				Asteriidae						
					Coronaster briareus	(sea star)	✓	✓	✓	✓
					Sclerasterias contorta	(sea star)	✓	✓	✓	✓
			Valvatida							
				Asteropseidae						
					Anthenoides piercei	(sea star)		✓		✓
				Benthopectinidae						
					Cheiraster sp.	(sea star)		✓	✓	✓
		Ophiuroidea								
			Phrynophiurida							
				Gorgonocephalidae						
					Astrogomphus vallatus	(basket star)		✓	✓	
	Echinozoa									
		Echinoidea								
			Temnopleuroida							
				Toxopneustidae						
					Lytechinus variegatus	green sea urchin	✓		✓	
			Spatangoida			(heart urchins)	✓		✓	

[1] Phylogeny is simplified and generally follows Camp et al. (1998), Cairns et al. (2002) for ctenophora, Turgeon et al. (1998) for mollusca, and Williams et al. (1989) for decapod crustacea.
[2] Scientific names generally follow Integrated Taxonomic Information System (www.ITIS.gov).
[3] Common names presented here are not necessarily widely used, especially in regards to names given in parentheses.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History

TABLE 17
Phylogenetic List of Fishes Captured by Trawl during the May 2011 Port Everglades Survey

Class[1]	Subclass	Division	Order	Family	Species[2]	Common Name[2]	When Collected		Inside or Outside Expansion Areas	
							Day	Night	Inside	Outside
Condrichthyes										
	Elasmobranchii									
			Torpediniformes							
				Narcinidae						
					Benthobatis marcida	blind torpedo	✓	✓	✓	✓
			Rajiformes							
				Rajiidae						
					Leucoraja garmani	rosette skate	✓	✓		✓
Actinopterygii										
	Neopterygii									
		Teleostei								
			Argentiniformes							
				Argentinidae						
					Argentina georgei	(argentine)		✓		✓
			Aulopiformes							
				Chlorophthalmidae						
					Chlorophthalmus cf. *agassizi*	shortnose greeneye		✓		✓
			Gadiformes							
				Moridae						
					Laemonema barbatulum	shortbeard codling		✓	✓	✓
					Physiculus fulvus	metallic codling	✓	✓	✓	
				Phycidae						
					Urophycis regia	spotted hake		✓	✓	✓
			Ophidiiformes							
				Ophidiidae						
					Lepophidium profundorum	fawn cusk-eel	✓	✓	✓	✓
			Lophiiformes							
				Lophiidae						
					Lophius gastrophysus	blackfin goosefish		✓		✓
			Scorpaeniformes							
				Scorpaenidae						
					Pontinus rathbuni	highfin scorpionfish		✓	✓	✓
				Peristediidae						
					Peristedion thompsoni	rimspine searobin		✓		✓
			Perciformes							
				Acropomatidae						
					Synagrops bellus	blackmouth bass	✓		✓	
				Carangidae						
					Caranx ruber	bar jack	✓		✓	
					Elagatis bipinnulata	rainbow runner	✓		✓	
				Callionymidae						
					Foetorepus agassizii	spotfin dragonet		✓	✓	
			Pleuronectiformes							
				Paralichthyidae						
					Citharichthys arctifrons	Gulf Stream flounder	✓	✓	✓	✓
					Paralichthys oblongus	fourspot flounder		✓		✓
				Bothidae						
					Monolene sessilicauda	deepwater flounder		✓		✓

[1] Phylogenetic relationships are simplified and follow Nelson (2006).

[2] Scientific and common names of species generally follow Nelson et al. (2004). Names in parentheses are not necessarily widely accepted.

Source: ANAMAR Environmental Consulting, Inc.

TABLE 18
Invertebrates Captured per Trawl during the May 2011 Port Everglades Survey

	Inside Expansion Areas				Outside Expansion Areas							
Station Number	PE11-6		PE11-7		PE11-8		PE11-9		Mean of Day Trawl Samples	Mean of Night Trawl Samples	Mean of Stations	Range of Stations
Abbreviated Sample ID	A	B	A	B	A	B	A	B				
Taxa[1] Day or Night Trawl:	Day	Night	Night	Day	Day	Night	Day	Night				
Cnidaria									–	–	–	– –
Scyphozoa	2	1			1	1			0.75	0.50	1.25	0 – 3
Hydrozoa: Hydroidolina		3					1	2	0.25	1.25	1.50	0 – 3
Species A (feathery)	1		4	2					0.75	1.00	1.75	0 – 6
Species B (branching)	1		1						0.25	0.25	0.50	0 – 1
Alcyonacea				2				1	0.50	0.25	0.75	0 – 2
Actiniaria	17	55	6	4	6	2	21	163	12.00	56.50	68.50	8 – 184
Mollusca									–	–	–	– –
Mytilidae									–	–	–	– –
Amygdalum sagittatum							1		0.25	0.00	0.25	0 – 1
Cardiidae									–	–	–	– –
Nemocardium peramabile								1	0.00	0.25	0.25	0 – 1
Poromyidae									–	–	–	– –
Poromya granulata						1			0.00	0.25	0.25	0 – 1
Verticordiidae									–	–	–	– –
Verticordia acuticostata			1						0.00	0.25	0.25	0 – 1
Cuspidariidae									–	–	–	– –
Cuspidaria rostrata							1	1	0.25	0.25	0.50	0 – 2
Sepiolidae									–	–	–	– –
Semirossia tenera					1		2		0.75	0.00	0.75	0 – 2
Sipuncula					2				0.50	0.00	0.50	0 – 2
Annelida									–	–	–	– –
Polychaeta				1				1	0.25	0.25	0.50	0 – 1
Sabellidae	1								0.25	0.00	0.25	0 – 1
Terebellidae				1					0.25	0.00	0.25	0 – 1
Maldanidae						1			0.00	0.25	0.25	0 – 1
Arthropoda									–	–	–	– –
Pycnogonida			1						0.00	0.25	0.25	0 – 1
Solenoceridae								1	0.00	0.25	0.25	0 – 1
Solenocera sp.						1		4	0.00	1.25	1.25	0 – 4
Pandalidae	1	2		1		1			0.50	0.75	1.25	0 – 3
Crangonidae						3			0.00	0.75	0.75	0 – 3
Pontophilus sp.	7		1	4					2.75	0.25	3.00	0 – 7
Nephropidae									–	–	–	– –
Nephropsis sp.		1				1		3	0.00	1.25	1.25	0 – 3
Diogenidae	2	5		1	1		4	7	2.00	3.00	5.00	1 – 11
Paguridae	2	1		1			1	2	1.00	0.75	1.75	0 – 3
Galatheidae									–	–	–	– –
Agononida longipes	5	8	1	5	14	35	1	2	6.25	11.50	17.75	3 – 49
Munida iris	2	9	3	22	3	18	2	37	7.25	16.75	24.00	11 – 39
Majidae			1	1		1			0.25	0.50	0.75	0 – 2
Pyromaia cuspidata							1	1	0.25	0.25	0.50	0 – 2
Cancridae									–	–	–	– –
Cancer borealis		3		1			1	4	0.50	1.75	2.25	0 – 5
Portunidae									–	–	–	– –
Bathynectes longispina	2	4	4	4	3	6	2	14	2.75	7.00	9.75	6 – 16
Pilumnidae				1					0.25	0.00	0.25	0 – 1
Goneplacidae									–	–	–	– –
Trizocarcinus tacitus		3							0.00	0.75	0.75	0 – 3
Brachyura					1		1		0.50	0.00	0.50	0 – 1
Verrucidae	11						1		3.00	0.00	3.00	0 – 11
Echinodermata									–	–	–	– –
Asteroidea					4				1.00	0.00	1.00	0 – 4
Asteriidae									–	–	–	– –
Coronaster briareus	95	130	89	96	74	131	123	139	97.00	122.25	219.25	185 – 262
Sclerasterias contorta	5	3	3	23		13	3	12	7.75	7.75	15.50	8 – 26
Asteropseidae									–	–	–	– –
Anthenoides piercei								2	0.00	0.50	0.50	0 – 2
Benthopectinidae									–	–	–	– –
Cheiraster sp.			1			1			0.00	0.50	0.50	0 – 1
Gorgonocephalidae									–	–	–	– –
Astrogomphus vallatus		2							0.00	0.50	0.50	0 – 2
Toxopneustidae									–	–	–	– –
Lytechinus variegatus				2					0.50	0.00	0.50	0 – 2
Spatangoida	1								0.25	0.00	0.25	0 – 1
Total	**155**	**230**	**116**	**172**	**110**	**216**	**166**	**397**	**150.75**	**239.75**	**390.50**	**288 – 563**

[1] Scientific names generally follow Integrated Taxonomic Information System (www.ITIS.gov).

Source: ANAMAR Environmental Consulting, Inc.

TABLE 19
Fishes Captured per Trawl during the May 2011 Port Everglades Survey

Station Number	Inside Expansion Areas				Outside Expansion Areas				Mean of Day Trawl Samples	Mean of Night Trawl Samples	Mean of Stations	Range of Stations
	PE11-6		PE11-7		PE11-8		PE11-9					
Abbreviated Sample ID	A	B	A	B	A	B	A	B				
Taxa[1] Day or Night Trawl:	Day	Night	Night	Day	Day	Night	Day	Night				
Narcinidae									–	–	–	– –
Benthobatis marcida	3	4			2			4	1.25	2.00	3.25	0 – 7
Rajiidae									–	–	–	– –
Leucoraja garmani							2	1	0.50	0.25	0.75	0 – 3
Argentinidae									–	–	–	– –
Argentina georgei								15	0.00	3.75	3.75	0 – 15
Chlorophthalmidae									–	–	–	– –
Chlorophthalmus cf. *agassizi*						2			0.00	0.50	0.50	0 – 2
Moridae									–	–	–	– –
Laemonema barbatulum		1				1		1	0.00	0.75	0.75	0 – 1
Physiculus fulvus		1		3					0.75	0.25	1.00	0 – 3
Phycidae									–	–	–	– –
Urophycis regia		1						17	0.00	4.50	4.50	0 – 17
Ophidiidae									–	–	–	– –
Lepophidium profundorum		5				2	1	68	0.25	18.75	19.00	0 – 69
Lophiidae									–	–	–	– –
Lophius gastrophysus								1	0.00	0.25	0.25	0 – 1
Scorpaenidae									–	–	–	– –
Pontinus rathbuni		1						7	0.00	2.00	2.00	0 – 7
Peristediidae									–	–	–	– –
Peristedion thompsoni								2	0.00	0.50	0.50	0 – 2
Acropomatidae									–	–	–	– –
Synagrops bellus	1								0.25	0.00	0.25	0 – 1
Callionymidae									–	–	–	– –
Foetorepus agassizii		1							0.00	0.25	0.25	0 – 1
Carangidae									–	–	–	– –
Caranx ruber	1								0.25	0.00	0.25	0 – 1
Elagatis bipinnulata	1								0.25	0.00	0.25	0 – 1
Paralichthyidae									–	–	–	– –
Citharichthys arctifrons	6	3		1			138	67	36.25	17.50	53.75	0 – 205
Paralichthys oblongus								3	0.00	0.75	0.75	0 – 3
Bothidae									–	–	–	– –
Monolene sessilicauda						2		2	0.00	1.00	1.00	0 – 2
Total	**12**	**17**	**0**	**4**	**2**	**7**	**141**	**188**	**39.75**	**53.00**	**92.75**	**4 – 329**

[1] Scientific names generally follow Nelson et al. (2004).

Source: ANAMAR Environmental Consulting, Inc.

TABLE 20
Major Epifaunal Group Densities per Station Captured by Trawl during the May 2011 Port Everglades Survey

Station Number / Major Taxonomic Groups per 1,000 m^2	Inside Expansion Areas		Outside Expansion Areas		Mean of Stations	Range of Stations
	PE11-6	PE11-7	PE11-8	PE11-9		
Cnidaria (jellyfishes, anemones, etc.)	11.18	1.98	0.93	18.50	8.15	0.93 – 18.50
Bivalves	None Caught	0.10	0.09	0.39	0.15	None Caught – 0.39
Squid	None Caught	None Caught	0.09	0.20	0.07	None Caught – 0.20
Sipunculid Worms	None Caught	None Caught	0.19	None Caught	0.05	None Caught – 0.19
Annelid Worms	0.14	0.21	0.09	0.10	0.14	0.09 – 0.21
Arthropods (crabs, shrimps, etc.)	9.50	5.43	8.21	8.76	7.98	5.43 – 9.50
Echinoderms (sea stars, urchins, etc.)	32.98	22.33	20.81	27.46	25.90	20.81 – 32.98
Fishes	4.05	0.42	0.84	32.38	9.42	0.42 – 32.38
Total Density per 1000 m^2	**57.86**	**30.47**	**31.27**	**87.79**	**51.85**	**30.47 – 87.79**

Note: Each station contains pooled trawl sample data (2 trawls per station).

Source: ANAMAR Environmental Consulting, Inc.

TABLE 21
Major Epifaunal Group Densities in Relation to the Expansion Areas Captured by Trawl during the May 2011 Port Everglades Survey

Area of Interest Pooled Station Numbers Major Taxonomic Groups per 1,000 m^2	Inside Expansion Areas PE11-6 & PE11-7	Outside Expansion Areas PE11-8 & PE11-9	Mean of Areas of Interest	Range of Areas of Interest
Cnidaria (jellyfishes, anemones, etc.)	5.91	9.49	7.70	5.91 – 9.49
Bivalves	0.06	0.24	0.15	0.06 – 0.24
Squid	None Caught	0.14	0.07	None Caught – 0.14
Sipunculid Worms	None Caught	0.10	0.05	None Caught – 0.10
Annelid Worms	0.18	0.10	0.14	0.10 – 0.18
Arthropods (crabs, shrimps, etc.)	7.17	8.48	7.82	7.17 – 8.48
Echinoderms (sea stars, urchins, etc.)	26.88	24.05	25.47	24.05 – 26.88
Fishes	1.97	16.19	9.08	1.97 – 16.19
Total Density per 1,000 m^2	**42.18**	**58.78**	**50.48**	**42.18 – 58.78**

Source: ANAMAR Environmental Consulting, Inc.

TABLE 22
Statistical Analysis of Epifauna per Station Captured by Trawl during the May 2011 Port Everglades Survey

Station Number[1]	Total Invertebrate Taxa	Total Fish Species	Total Number of Taxa	Total Number of Individuals	Total Density (individuals/ 1,000 m^2)	H' Shannon Diversity Index (log e)	J' Pielou Evenness Index	D Margalef Richness Index
PE11-6	21	11	32	414	57.86	1.85	0.53	5.14
PE11-7	22	2	24	292	30.47	1.54	0.48	4.05
PE11-8	20	5	25	335	31.27	1.54	0.48	4.13
PE11-9	23	12	35	892	87.79	2.08	0.58	5.00

[1] Station data consists of pooled trawl samples (2 trawls per station).

Source: ANAMAR Environmental Consulting, Inc.

TABLE 23
Abundant Epifaunal Taxa Captured by Trawl during the May 2011 Port Everglades Survey

MOST ABUNDANT TRAWLED INVERTEBRATE TAXA[1]	Total Individuals Collected (*n* =)	% of Total Invertebrates Caught (*N* = 1,562)
Actiniaria (sea anemones)	274	17.54
Agononida longipes (a squat lobster)	71	4.55
Munida iris (a squat lobster)	96	6.15
Bathynectes longispina (bathyal swimming crab)	39	2.50
Coronaster briareus (a sea star)	877	56.15
Sclerasterias contorta (a sea star)	62	3.97
MOST ABUNDANT TRAWLED FISH SPECIES[1]	**Total Individuals Collected (*n* =)**	**% of Total Fishes Caught (*N* = 371)**
Benthobatis marcida (blind torpedo)	13	3.50
Argentina georgei (argentine)	15	4.04
Urophycis regia (spotted hake)	18	4.85
Lepophidium profundorum (fawn cusk-eel)	76	20.49
Pontinus rathbuni (highfin scorpionfish)	8	2.16
Citharichthys arctifrons (Gulf Stream flounder)	215	57.95

[1] Abundant taxa are those constituting ≥2% of total invertebrates or fishes captured during the trawl survey.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History

TABLE 24
Abundant Epifaunal Taxa Densities per Station Captured by Trawl during the May 2011 Port Everglades Survey

Station Number / Abundant Trawled Taxa[1] Densities (per 1,000 m^2)	Inside Expansion Areas		Outside Expansion Areas		Mean of Stations	Range of Stations
	PE11-6	PE11-7	PE11-8	PE11-9		
Actiniaria (sea anemones)	10.06	1.04	0.75	18.11	7.49	0.75 – 18.11
***Agononida longipes* (a squat lobster)**	1.82	0.63	4.57	0.30	1.83	0.30 – 4.57
***Munida iris* (a squat lobster)**	1.54	2.61	1.96	3.84	2.49	1.54 – 3.84
***Bathynectes longispina* (bathyal swimming crab)**	0.84	0.83	0.84	1.57	1.02	0.83 – 1.57
***Coronaster briareus* (a sea star)**	31.45	19.31	19.13	25.78	23.92	19.13 – 31.45
***Sclerasterias contorta* (a sea star)**	1.12	2.71	1.21	1.48	1.63	1.12 – 2.71
***Benthobatis marcida* (blind torpedo)**	0.98	None Caught	0.19	0.39	0.39	None Caught – 0.98
***Argentina georgei* (argentine)**	None Caught	None Caught	None Caught	1.48	0.37	None Caught – 1.48
***Urophycis regia* (spotted hake)**	0.14	None Caught	None Caught	1.67	0.45	None Caught – 1.67
***Lepophidium profundorum* (fawn cusk-eel)**	0.70	None Caught	0.19	6.79	1.92	None Caught – 6.79
***Pontinus rathbuni* (highfin scorpionfish)**	0.14	None Caught	None Caught	0.69	0.21	None Caught – 0.69
***Citharichthys arctifrons* (Gulf Stream flounder)**	1.26	0.10	None Caught	20.18	5.38	None Caught – 20.18
Total Abundant Taxa Density (per 1,000 m^2)	**50.03**	**27.24**	**28.84**	**82.28**	**47.10**	**27.24 – 82.28**

[1] Abundant taxa are those constituting ≥2% of total invertebrates or fishes captured during the trawl survey.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History

TABLE 25
Abundant Invertebrate and Fish Densities in Relation to the Expansion Areas Captured by Trawl during the May 2011 Port Everglades Survey

Area of Interest / Pooled Station Numbers / Abundant Trawled Taxa[1] Densities (per 1,000 m^2)	Inside Expansion Areas PE11-6 & PE11-7	Outside Expansion Areas PE11-8 & PE11-9	Mean of Areas of Interest	Range of Areas of Interest
Actiniaria (sea anemones)	4.90	9.20	7.05	4.90 – 9.20
***Agononida longipes* (a squat lobster)**	1.14	2.49	1.81	1.14 – 2.49
***Munida iris* (a squat lobster)**	2.15	2.87	2.51	2.15 – 2.87
***Bathynectes longispina* (bathyal swimming crab)**	0.84	1.20	1.02	0.84 – 1.20
***Coronaster briareus* (a sea star)**	24.50	22.37	23.43	22.37 – 24.50
***Sclerasterias contorta* (a sea star)**	2.03	1.34	1.69	1.34 – 2.03
***Benthobatis marcida* (blind torpedo)**	0.42	0.29	0.35	0.29 – 0.42
***Argentina georgei* (argentine)**	None Caught	0.72	0.36	None Caught – 0.72
***Urophycis regia* (spotted hake)**	0.06	0.81	0.44	0.06 – 0.81
***Lepophidium profundorum* (fawn cusk-eel)**	0.30	3.40	1.85	0.30 – 3.40
***Pontinus rathbuni* (highfin scorpionfish)**	0.06	0.34	0.20	0.06 – 0.34
***Citharichthys arctifrons* (Gulf Stream flounder)**	0.60	9.82	5.21	0.60 – 9.82
Total Abundant Taxa Density (per 1,000 m^2)	**36.98**	**54.85**	**45.92**	**36.98 – 54.85**

[1]Abundant epifaunal taxa are those constituting ≥2% of total invertebrates or fishes captured during the trawl survey.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History

TABLE 26
Managed Invertebrates and Fishes per Station Captured by Trawl during the May 2011 Port Everglades Survey

Site Number / Managed Taxa / Station Number	Inside Expansion Areas		Outside Expansion Areas		Mean of Stations	Range of Stations
	PE11-6	PE11-7	PE11-8	PE11-9		
Hydrozoa: Hydroidolina (hydroids)[SAFMC]	3	0	0	3	1.50	0 – 3
Hydrozoa: Hydroidolina, Species A (feathery hydroids)[SAFMC]	1	6	0	0	1.75	0 – 6
Hydrozoa: Hydroidolina, Species B (branching hydroids)[SAFMC]	1	1	0	0	0.50	0 – 1
Alcyonacea (true soft corals)[SAFMC]	0	2	0	1	0.75	0 – 2
Actiniaria (sea anemones)[SAFMC]	72	10	8	184	68.50	8 – 184
Diogenidae (left-handed hermit crabs)[FWC]	7	1	1	11	5.00	1 – 11
Paguridae (right-handed hermit crabs)[FWC]	3	1	0	3	1.75	0 – 3
Coronaster briareus **(a sea star)**[FWC]	225	185	205	262	219.25	185 – 262
Sclerasterias contorta **(a sea star)**[FWC]	8	26	13	15	15.50	8 – 26
Anthenoides piercei **(a sea star)**[FWC]	0	0	0	2	0.50	0 – 2
Cheiraster **sp. (a sea star genus)**[FWC]	0	1	1	0	0.50	0 – 1
Astrogomphus vallatus **(basket star)**[FWC]	2	0	0	0	0.50	0 – 2
Lytechinus variegatus **(green sea urchin)**[FWC]	0	2	0	0	0.50	0 – 2
Spatangoida (heart urchins)[FWC]	1	0	0	0	0.25	0 – 1
Caranx ruber **(bar jack)**[SAFMC]	1	0	0	0	0.25	0 – 1
Total Managed Individuals	**324**	**235**	**228**	**481**	**317.00**	**228 – 481**

[SAFMC] Taxa managed by the South Atlantic Fishery Management Council, including all members of the classes hydrozoa and anthozoa. The SAFMC management area includes Florida's east coast federal waters. Management of hydroids, soft corals, and sea anemones is expected to be handed over to FWC by the end of 2011, once federal rules are modified to accommodate this change (L. Gregg *pers. comm*.).

[FWC] Taxa managed by the Florida Fish and Wildlife Conservation Commission in Florida waters and federal waters adjacent to Florida.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 27
Managed Invertebrate and Fish Densities per Station Captured by Trawl during the May 2011 Port Everglades Survey

Site Number / Managed Taxa Densities (per 1,000 m^2) / Station Number	Inside Expansion Areas		Outside Expansion Areas		Mean of Stations	Range of Stations
	PE11-6	PE11-7	PE11-8	PE11-9		
Hydrozoa: Hydroidolina (hydroids)[SAFMC]	0.42	None Caught	None Caught	0.30	0.18	None Caught – 0.42
Hydrozoa: Hydroidolina, Species A (feathery hydroids)[SAFMC]	0.14	0.63	None Caught	None Caught	0.19	None Caught – 0.63
Hydrozoa: Hydroidolina, Species B (branching hydroids)[SAFMC]	0.14	0.10	None Caught	None Caught	0.06	None Caught – 0.14
Alcyonacea (true soft corals)[SAFMC]	None Caught	0.21	None Caught	0.10	0.08	None Caught – 0.21
Actiniaria (sea anemones)[SAFMC]	10.06	1.04	0.75	18.11	7.49	0.75 – 18.11
Diogenidae (left-handed hermit crabs)[FWC]	0.98	0.10	0.09	1.08	0.56	0.09 – 1.08
Paguridae (right-handed hermit crabs)[FWC]	0.42	0.10	None Caught	0.30	0.20	None Caught – 0.42
***Coronaster briareus* (a sea star)[FWC]**	31.45	19.31	19.13	25.78	23.92	19.13 – 31.45
***Sclerasterias contorta* (a sea star)[FWC]**	1.12	2.71	1.21	1.48	1.63	1.12 – 2.71
***Anthenoides piercei* (a sea star)[FWC]**	None Caught	None Caught	None Caught	0.20	0.05	None Caught – 0.20
***Cheiraster* sp. (a sea star genus)[FWC]**	None Caught	0.10	0.09	None Caught	0.05	None Caught – 0.10
***Astrogomphus vallatus* (basket star)[FWC]**	0.28	None Caught	None Caught	None Caught	0.07	None Caught – 0.28
***Lytechinus variegatus* (green sea urchin)[FWC]**	None Caught	0.21	None Caught	None Caught	0.05	None Caught – 0.21
Spatangoida (heart urchins)[FWC]	0.14	None Caught	None Caught	None Caught	0.03	None Caught – 0.14
***Caranx ruber* (bar jack)[SAFMC]**	0.14	None Caught	None Caught	None Caught	0.03	None Caught – 0.14
Total Managed Taxa Densities (per 1,000 m^2)	**45.29**	**24.52**	**21.27**	**47.34**	**34.61**	**21.27 – 47.34**

[SAFMC] Taxa managed by the South Atlantic Fishery Management Council, including all members of the classes hydrozoa and anthozoa. The SAFMC management area includes Florida's east coast federal waters. Management of hydroids, soft corals, and sea anemones is expected to be handed over to FWC by the end of 2011, once federal rules are modified to accommodate this change (L. Gregg *pers. comm*.).

[FWC] Taxa managed by the Florida Fish and Wildlife Conservation Commission in Florida waters and federal waters adjacent to Florida.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 28
Managed Invertebrates and Fishes in Relation to the Expansion Areas Captured by Trawl during the May 2011 Port Everglades Survey

Area of Interest / Managed Taxa / Pooled Station Numbers	Inside Expansion Areas PE11-6 & PE11-7	Outside Expansion Areas PE11-8 & PE11-9	Mean of Areas of Interest	Range of Areas of Interest
Hydrozoa: Hydroidolina (hydroids)[SAFMC]	3	3	3.00	3 – 3
Hydrozoa: Hydroidolina, Species A (feathery hydroids)[SAFMC]	7	0	3.50	0 – 7
Hydrozoa: Hydroidolina, Species B (branching hydroids)[SAFMC]	2	0	1.00	0 – 2
Alcyonacea (true soft corals)[SAFMC]	2	1	1.50	1 – 2
Actiniaria (sea anemones)[SAFMC]	82	192	137.00	82 – 192
Diogenidae (left-handed hermit crabs)[FWC]	8	12	10.00	8 – 12
Paguridae (right-handed hermit crabs)[FWC]	4	3	3.50	3 – 4
Coronaster briareus **(a sea star)[FWC]**	410	467	438.50	410 – 467
Sclerasterias contorta **(a sea star)[FWC]**	34	28	31.00	28 – 34
Anthenoides piercei **(a sea star)[FWC]**	0	2	1.00	0 – 2
Cheiraster **sp. (a sea star genus)[FWC]**	1	1	1.00	1 – 1
Astrogomphus vallatus **(basket star)[FWC]**	2	0	1.00	0 – 2
Lytechinus variegatus **(green sea urchin)[FWC]**	2	0	1.00	0 – 2
Spatangoida (heart urchins)[FWC]	1	0	0.50	0 – 1
Caranx ruber **(bar jack)[SAFMC]**	1	0	0.50	0 – 1
Total Managed Individuals	**559**	**709**	**634.00**	**559 – 709**

[SAFMC] Taxa managed by the South Atlantic Fishery Management Council, including all members of the classes hydrozoa and anthozoa. The SAFMC management area includes Florida's east coast federal waters. Management of hydroids, soft corals, and sea anemones is expected to be handed over to FWC by the end of 2011, once federal rules are modified to accommodate this change (L. Gregg *pers. comm*.).

[FWC] Taxa managed by the Florida Fish and Wildlife Conservation Commission in Florida waters and federal waters adjacent to Florida.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 29
Managed Invertebrate and Fish Densities in Relation to the Expansion Areas Captured by Trawl during the May 2011 Port Everglades Survey

Area of Interest / Pooled Station Numbers / Managed Taxa Densities (per 1,000 m^2)	Inside Expansion Areas PE11-6 & PE11-7	Outside Expansion Areas PE11-8 & PE11-9	Mean of Areas of Interest	Range of Areas of Interest
Hydrozoa: Hydroidolina (hydroids)[SAFMC]	0.18	0.14	0.16	0.14 – 0.18
Hydrozoa: Hydroidolina, Species A (feathery hydroids)[SAFMC]	0.42	None Caught	0.21	None Caught – 0.42
Hydrozoa: Hydroidolina, Species B (branching hydroids)[SAFMC]	0.12	None Caught	0.06	None Caught – 0.12
Alcyonacea (true soft corals)[SAFMC]	0.12	0.05	0.08	0.05 – 0.12
Actiniaria (sea anemones)[SAFMC]	4.90	9.20	7.05	4.90 – 9.20
Diogenidae (left-handed hermit crabs)[FWC]	0.48	0.57	0.53	0.48 – 0.57
Paguridae (right-handed hermit crabs)[FWC]	0.24	0.14	0.19	0.14 – 0.24
Coronaster briareus **(a sea star)[FWC]**	24.50	22.37	23.43	22.37 – 24.50
Sclerasterias contorta **(a sea star)[FWC]**	2.03	1.34	1.69	1.34 – 2.03
Anthenoides piercei **(a sea star)[FWC]**	None Caught	0.10	0.05	None Caught – 0.10
Cheiraster **sp. (a sea star genus)[FWC]**	0.06	0.05	0.05	0.05 – 0.06
Astrogomphus vallatus **(basket star)[FWC]**	0.12	None Caught	0.06	None Caught – 0.12
Lytechinus variegatus **(green sea urchin)[FWC]**	0.12	None Caught	0.06	None Caught – 0.12
Spatangoida (heart urchins)[FWC]	0.06	None Caught	0.03	None Caught – 0.06
Caranx ruber **(bar jack)[SAFMC]**	0.06	None Caught	0.03	None Caught – 0.06
Total Managed Taxa Densities (per 1,000 m^2)	**33.40**	**33.96**	**33.68**	**33.40 – 33.96**

[SAFMC] Taxa managed by the South Atlantic Fishery Management Council, including all members of the classes hydrozoa and anthozoa. The SAFMC management area includes Florida's east coast federal waters. Management of hydroids, soft corals, and sea anemones is expected to be handed over to FWC by the end of 2011, once federal rules are modified to accommodate this change (L. Gregg *pers. comm*.).

[FWC] Taxa managed by the Florida Fish and Wildlife Conservation Commission in Florida waters and federal waters adjacent to Florida.

Sources: ANAMAR Environmental Consulting, Inc. in collaboration with the Florida Museum of Natural History Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 30
Invertebrate and Fish Tissue Sample Weights, Numbers of Specimens, and Analyses by Station

Station Number(s)[1]	Abbeviated Sample ID	Composite Sample?	Includes Field Split?	Species	Number of Specimens	Tissue Weight[4] (grams)	Analyses Conducted
PE11-5 & PE11-10	5-10-COMP-A	Yes	No	Spotted hake[2]	2 (PE11-5) + 5 (PE11-10) = 7 total	132	Metals, lipids, PAHs, pesticides, organotins, and PCBs
PE11-5 & PE11-10	5-10-COMP-B	Yes	No	Jonah crab[3]	2 (PE11-5) + 3 (PE11-10) = 5 total	110	Metals, lipids, PAHs, pesticides, organotins, and PCBs
PE11-6 & PE11-7	6-7-COMP-A	Yes	No	Spotted hake[2]	2 (PE11-6) + 3 (PE11-7) = 5 total	55	Metals, lipids, PAHs, pesticides, organotins, and PCBs
PE11-9	9-TIS-A	No	Yes	Spotted hake[2]	17	>200	Metals, lipids, PAHs, pesticides, organotins, and PCBs
PE11-9	9-TIS-B	No	No	Jonah crab[3]	3	>100	Metals, lipids, PAHs, pesticides, organotins, and PCBs
PE11-14	14-TIS-A	No	No	Jonah crab[3]	4	76	Metals, lipids, solids, pesticides, organotins, and PCBs

[1] The tissue trawl labeled as PE11-10 was not actually conducted at Station PE11-10. This trawl was conducted southwest of the expansion areas.

[2] *Urophycis regia*, mean standard length = approx. 200 mm; many were female (as observed during tissue extractions). All were immature based on Klein-MacPhee (2002).

[3] *Cancer borealis*, mean carapace width = approx. 120 mm; both sexes were represented. All were mature or nearly so based on Robichaud and Frail (2006).

[4] Weighed onboard the vessel using a tared 100-gram Micro Line hanging scale.

Source: ANAMAR Environmental Consulting, Inc.

TABLE 31
Results of Wet Weight Bioaccumulated Metal and Organotin Analysis of Tissue Collected during the May 2011 Port Everglades Survey

	Species Sampled:			Spotted Hake												Jonah Crab											
	Max. Detected Concentrations		Sample ID:	5-10-COMP-A				6-7-COMP-A				9-TIS-A				9-TIS-A (Field Split)				5-10-COMP-B				9-TIS-B				14-TIS-A			
				Outside Expansion Areas				Inside Expansion Areas				Outside Expansion Areas				Outside Expansion Areas				Outside Expansion Areas				Outside Expansion Areas				Inside Expansion Areas			
Analyte	Spotted Hake mg/kg	Jonah Crab mg/kg	FDA Level[1]: Crustacea mg/kg	Result mg/kg	Qualifier	MDL	MRL[2]	Result mg/kg	Qualifier	MDL	MRL[2]	Result mg/kg	Qualifier	MDL	MRL[2]	Result mg/kg	Qualifier	MDL	MRL[2]	Result mg/kg	Qualifier	MDL	MRL[2]	Result mg/kg	Qualifier	MDL	MRL[2]	Result mg/kg	Qualifier	MDL	MRL[2]
Arsenic	47.50	**122**	76	30.90	–	0.007	0.089	31.50	–	0.007	0.092	47.50	–	0.007	0.091	33.50	–	0.007	0.089	**117**	–	0.193	2.410	**106**	–	0.176	2.200	**122**	–	0.187	2.340
Cadmium	0.0062	0.0494	3	0.0051	–	0.0009	0.0035	0.0027	J	0.0009	0.0037	0.0049	–	0.0009	0.0036	0.0062	–	0.0009	0.0036	0.0244	–	0.0012	0.0048	0.0494	–	0.0011	0.0044	0.0170	–	0.0012	0.0047
Chromium	0.13	0.07	12	0.07	–	0.01	0.04	0.05	–	0.02	0.04	0.13	–	0.02	0.04	0.06	–	0.01	0.04	0.05	–	0.02	0.05	0.07	–	0.02	0.04	0.06	–	0.02	0.05
Copper	0.221	13.6	x	0.221	–	0.005	0.018	0.145	–	0.006	0.018	0.154	–	0.005	0.018	0.167	–	0.005	0.018	13.6	–	0.007	0.024	7.580	–	0.007	0.022	12.0	–	0.007	0.023
Lead	0.0208	0.0257	1.5	0.0154	–	0.0009	0.0035	0.0133	–	0.0009	0.0037	0.0136	–	0.0009	0.0036	0.0208	–	0.0009	0.0036	0.0257	–	0.0012	0.0048	0.0223	–	0.0011	0.0044	0.0243	–	0.0012	0.0047
Mercury	0.2204	0.2764	1	0.2204	–	0.0014	0.0143	0.0948	–	0.0015	0.0147	0.1758	–	0.0014	0.0144	0.2150	–	0.0014	0.0140	0.2578	–	0.0019	0.0192	0.1406	–	0.0018	0.0177	0.2764	–	0.0019	0.0188
Nickel	0.059	0.188	70	0.059	–	0.004	0.035	0.039	–	0.004	0.037	0.049	–	0.004	0.036	0.042	–	0.004	0.036	0.183	–	0.005	0.048	0.140	–	0.004	0.044	0.188	–	0.005	0.047
Silver	ND	0.240	x	ND	U	0.004	0.004	ND	U	0.004	0.004	ND	U	0.004	0.004	ND	U	0.004	0.004	0.208	–	0.005	0.005	0.162	–	0.004	0.004	0.240	–	0.005	0.005
Zinc	3.17	71.3	x	3.17	–	0.01	0.09	3.10	–	0.02	0.09	2.79	–	0.02	0.09	2.83	–	0.01	0.09	71.3	–	0.39	2.41	65.1	–	0.35	2.20	66.4	–	0.37	2.34
Analyte	**Max. Detected Conc. (%)**	**Max. Detected Conc. (%)**	**FDA level[1]: Crustacea**	**Result %**	**Qualifier**	**MDL**	**MRL[2]**	**Result %**	**Qualifier**	**MDL**	**MRL[2]**	**Result %**	**Qualifier**	**MDL**	**MRL[2]**	**Result %**	**Qualifier**	**MDL**	**MRL[2]**	**Result %**	**Qualifier**	**MDL**	**MRL[2]**	**Result %**	**Qualifier**	**MDL**	**MRL[2]**	**Result %**	**Qualifier**	**MDL**	**MRL[2]**
Lipids, Total	0.38	0.59	x	0.33	–	–	0.05	0.37	–	–	0.05	0.38	–	–	0.05	0.33	–	–	0.05	0.35	–	–	0.05	0.35	–	–	0.05	0.59	–	–	0.05
Solids, Total	18.6	24.2	x	17.9	–	–	–	18.6	–	–	–	18.3	–	–	–	17.8	–	–	–	24.2	–	–	–	22.1	–	–	–	23.6	–	–	–
Analyte	**Max. Detected Conc. (µg/kg)**	**Max. Detected Conc. (µg/kg)**	**FDA level[1]: Crustacea (µg/kg)**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[2]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[2]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[2]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[2]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[2]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[2]**	**Result µg/kg**	**Qualifier**	**MDL**	**MRL[2]**
Tri-n-butyltin Cation	ND	ND	x	ND	U	0.12	1.1	ND	U	0.11	0.95	ND	U	0.12	1.1	ND	U	0.11	0.99	ND	U	0.11	0.86	ND	U	0.12	1.1	ND	U	0.12	1.1
Di-n-butyltin Cation	ND	ND	x	ND	U	0.12	1.1	ND	U	0.11	0.95	ND	U	0.12	1.1	ND	U	0.11	0.99	ND	U	0.11	0.86	ND	U	0.12	1.1	ND	U	0.12	1.1
n-Butyltin Cation	ND	ND	x	ND	U	0.19	1.1	ND	U	0.18	0.95	ND	U	0.19	1.1	ND	U	0.18	0.99	ND	U	0.18	0.86	ND	U	0.19	1.1	ND	U	0.20	1.1
Total Organotins (as Sn)	0.24	0.25	x	0.24	–	–	–	0.22	–	–	–	0.24	–	–	–	0.22	–	–	–	0.22	–	–	–	0.24	–	–	–	0.25	–	–	–

[1] FDA = U.S. Food and Drug Administration levels for crustacea (from Appendix H of SERIM), with decimal places preserved from the source document (FDA 2001). See Section 3.5 for a discussion.

[2] MRL = method reporting limit, assigned by Columbia Analytical Services to a fixed factor above the method detection limit (MDL) depending on the analyte, unless otherwise specified.

[3] U-qualified results calculated using the MDL. See SERIM for more information.

– = no qualifier needed or no analysis performed for that analyte.

Numbers in bold denote a value greater than or equal to the FDA level for crustacea.

ND = not detected at or above the method detection limit (MDL).

J = the result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

U = the compound was analyzed for but not detected at or above the MDL.

x = no FDA level published for parameter.

Source: Columbia Analytical Services, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 32
Results of Wet Weight Bioaccumulated Organochlorine Pesticide Analyses of Tissue Collected during the May 2011 Port Everglades Survey

Species Sampled:			Spotted Hake														Jonah Crab											
	Max. Detected Concentrations		5-10-COMP-A				6-7-COMP-A				9-TIS-A				9-TIS-A (Field Split)				5-10-COMP-B				9-TIS-B				14-TIS-A			
			Outside Expansion Areas				Inside Expansion Areas				Outside Expansion Areas				Outside Expansion Areas				Outside Expansion Areas				Outside Expansion Areas				Inside Expansion Areas			
Analyte	Spotted Hake µg/kg	Jonah Crab µg/kg	Sample ID: FDA level[1]: Crustacea µg/kg	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]
Aldrin	ND	ND	300	ND	U	0.74	0.89	ND	U	0.74	0.86	ND	U	0.74	0.90	ND	U	0.74	0.89	ND	U	0.74	0.85	ND	U	0.74	0.88	ND	U	0.74	0.89
Chlordane & Derivatives																															
Technical Chlordane	ND	ND	300 (combined)	ND	U	3.3	8.9	ND	U	3.3	8.6	ND	U	3.3	9.0	ND	U	3.3	8.9	ND	U	3.3	8.5	ND	U	3.3	8.8	ND	U	3.3	8.9
α (cis)-Chlordane	ND	ND		ND	U	0.25	0.89	ND	U	0.25	0.86	ND	U	0.25	0.90	ND	U	0.25	0.89	ND	U	0.25	0.85	ND	U	0.25	0.88	ND	U	0.25	0.89
γ (trans)-Chlordane	ND	ND		ND	U	0.26	0.89	ND	U	0.26	0.86	ND	U	0.26	0.90	ND	U	0.26	0.89	ND	U	0.26	0.85	ND	U	0.26	0.88	ND	U	0.26	0.89
cis-Nonachlor	ND	ND		ND	U	0.29	0.89	ND	U	0.29	0.86	ND	U	0.29	0.90	ND	U	0.29	0.89	ND	U	0.29	0.85	ND	U	0.29	0.88	ND	U	0.29	0.89
Oxychlordane	ND	ND		ND	U	0.39	0.89	ND	U	0.39	0.86	ND	U	0.39	0.90	ND	U	0.39	0.89	ND	U	0.39	0.85	ND	U	0.39	0.88	ND	U	0.39	0.89
trans-Nonachlor	ND	ND		ND	U	0.27	0.89	ND	U	0.27	0.86	ND	U	0.27	0.90	ND	U	0.27	0.89	ND	U	0.27	0.85	ND	U	0.27	0.88	ND	U	0.27	0.89
DDT & Derivatives																															
p,p' (4,4')-DDD	ND	ND	5,000	ND	U	0.55	0.89	ND	U	0.55	0.86	ND	U	0.55	0.90	ND	U	0.55	0.89	ND	U	0.55	0.85	ND	U	0.55	0.88	ND	U	0.55	0.89
p,p' (4,4')-DDE	0.71	0.68		0.71	J	0.45	0.89	ND	U	0.45	0.86	ND	U	0.45	0.90	ND	U	0.45	0.89	ND	U	0.45	0.85	0.68	J	0.45	0.88	0.51	J	0.45	0.89
p,p' (4,4')-DDT	0.49	ND		ND	U	0.49	0.89	ND	U	0.49	0.86	ND	U	0.49	0.90	0.49	J,P	0.49	0.89	ND	U	0.49	0.85	ND	U	0.49	0.88	ND	U	0.49	0.89
Dieldrin	ND	ND	300	ND	U	0.20	0.89	ND	U	0.20	0.86	ND	U	0.20	0.90	ND	U	0.20	0.89	ND	U	0.20	0.85	ND	U	0.20	0.88	ND	U	0.20	0.89
Endosulfan & Derivatives																															
Endosulfan I	ND	ND	x	ND	U	0.22	0.89	ND	U	0.22	0.86	ND	U	0.22	0.90	ND	U	0.22	0.89	ND	U	0.22	0.85	ND	U	0.22	0.88	ND	U	0.22	0.89
Endosulfan II	ND	ND	x	ND	U	0.24	0.89	ND	U	0.24	0.86	ND	U	0.24	0.90	ND	U	0.24	0.89	ND	U	0.24	0.85	ND	U	0.24	0.88	ND	U	0.24	0.89
Endrin & Derivatives																															
Endrin	ND	ND	x	ND	U	0.28	0.89	ND	U	0.28	0.86	ND	U	0.28	0.90	ND	U	0.28	0.89	ND	U	0.28	0.85	ND	U	0.28	0.88	ND	U	0.28	0.89
Endrin Aldehyde	ND	ND	x	ND	U	0.62	0.89	ND	U	0.62	0.86	ND	U	0.62	0.90	ND	U	0.62	0.89	ND	U	0.62	0.85	ND	U	0.62	0.88	ND	U	0.62	0.89
Endrin Ketone	ND	ND	x	ND	U	0.39	0.89	ND	U	0.39	0.86	ND	U	0.39	0.90	ND	U	0.39	0.89	ND	U	0.39	0.85	ND	U	0.39	0.88	ND	U	0.39	0.89
Heptachlor & Derivatives																															
Heptachlor	ND	ND	300	ND	U	0.27	0.89	ND	U	0.27	0.86	ND	U	0.27	0.90	ND	U	0.27	0.89	ND	U	0.27	0.85	ND	U	0.27	0.88	ND	U	0.27	0.89
Heptachlor Epoxide	ND	ND	300	ND	U	0.18	0.89	ND	U	0.18	0.86	ND	U	0.18	0.90	ND	U	0.18	0.89	ND	U	0.18	0.85	ND	U	0.18	0.88	ND	U	0.18	0.89
Hexachlorocyclohexane (BHC)																															
α-BHC	ND	ND	x	ND	U	0.16	0.89	ND	U	0.16	0.86	ND	U	0.16	0.90	ND	U	0.16	0.89	ND	U	0.16	0.85	ND	U	0.16	0.88	ND	U	0.16	0.89
β-BHC	0.63	ND	x	ND	U	0.41	0.89	ND	U	0.41	0.86	0.63	J	0.41	0.90	ND	U	0.41	0.89	ND	U	0.41	0.85	ND	U	0.41	0.88	ND	U	0.41	0.89
γ-BHC (Lindane)	ND	ND	x	ND	U	0.21	0.89	ND	U	0.21	0.86	ND	U	0.21	0.90	ND	U	0.21	0.89	ND	U	0.21	0.85	ND	U	0.21	0.88	ND	U	0.21	0.89
δ-BHC	ND	ND	x	ND	U	0.20	0.89	ND	U	0.20	0.86	ND	U	0.20	0.90	ND	U	0.20	0.89	ND	U	0.20	0.85	ND	U	0.20	0.88	ND	U	0.20	0.89
Methoxychlor	ND	ND	x	ND	U	0.48	0.89	ND	U	0.48	0.86	ND	U	0.48	0.90	ND	U	0.48	0.89	ND	U	0.48	0.85	ND	U	0.48	0.88	ND	U	0.48	0.89
Mirex®	ND	ND	100	ND	U	0.26	0.89	ND	U	0.26	0.86	ND	U	0.26	0.90	ND	U	0.26	0.89	ND	U	0.26	0.85	ND	U	0.26	0.88	ND	U	0.26	0.89
Toxaphene	ND	ND	x	ND	U	13	45	ND	U	13	43	ND	U	13	45	ND	U	13	45	ND	U	13	43	ND	U	13	44	ND	U	13	45

[1] FDA = U.S. Food and Drug Administration levels for crustacea taken from Appendix H of the SERIM with decimal places preserved from the source document (FDA 2001). FDA level for DDT derivatives and Mirex ® taken from Table 9-1 of FDA (2001).

[2] MRL = method reporting limit is defined as the lowest instrument calibration standard.

ND = not detected at or above the method detection limit (MDL).

J = the result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

x = no FDA level published for parameter.

P = the GC or HPLC confirmaton criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results (25% for CLP Pesticides).

U = the compound was analyzed for but not detected at or above the MDL.

Source: Columbia Analytical Services, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 33
Results of Wet Weight Bioaccumulated PAH Analyses of Tissue Collected during the May 2011 Port Everglades Survey

	Species Sampled:			Spotted Hake																Jonah Crab											
	Max. Detected Concentrations		Station ID:	5-10-COMP-A Outside Expansion Areas				6-7-COMP-A Inside Expansion Areas				9-TIS-A Outside Expansion Areas				9-TIS-A (Field Split) Outside Expansion Areas				5-10-COMP-B Outside Expansion Areas				9-TIS-B Outside Expansion Areas				14-TIS-A Inside Expansion Areas			
Analyte	Spotted Hake µg/kg	Jonah Crab µg/kg	FDA level[1]: Crustacea µg/kg	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]	Result µg/kg	Qualifier	MDL	MRL[2]
1-Methylnaphthalene[LMW]	ND	ND	x	ND	U	0.55	20	ND	U	0.58	21	ND	U	0.55	20	ND	U	0.56	21	ND	U	0.55	20	ND	U	0.62	23	ND	U	0.56	21
2-Methylnaphthalene[LMW]	ND	ND	x	ND	U	0.60	20	ND	U	0.63	21	ND	U	0.60	20	ND	U	0.61	21	ND	U	0.60	20	ND	U	0.67	23	ND	U	0.61	21
Acenaphthene[LMW]	ND	ND	x	ND	U	0.24	20	ND	U	0.25	21	ND	U	0.24	20	ND	U	0.24	21	ND	U	0.24	20	ND	U	0.27	23	ND	U	0.24	21
Acenaphthylene	ND	ND	x	ND	U	0.23	20	ND	U	0.24	21	ND	U	0.23	20	ND	U	0.24	21	ND	U	0.23	20	ND	U	0.26	23	ND	U	0.24	21
Anthracene[LMW]	ND	ND	x	ND	U	0.19	20	ND	U	0.20	21	ND	U	0.19	20	ND	U	0.20	21	ND	U	0.19	20	ND	U	0.22	23	ND	U	0.20	21
Benzo(a)anthracene[HMW]	0.46	ND	x	ND	U	0.19	20	ND	U	0.20	21	0.46	J	0.19	20	ND	U	0.20	21	ND	U	0.19	20	ND	U	0.22	23	ND	U	0.20	21
Benzo(a)pyrene[HMW]	ND	ND	x	ND	U	0.37	20	ND	U	0.38	21	ND	U	0.37	20	ND	U	0.37	21	ND	U	0.37	20	ND	U	0.41	23	ND	U	0.37	21
Benzo(b)fluoranthene	0.57	ND	x	ND	U	0.33	20	ND	U	0.35	21	0.57	J	0.33	20	ND	U	0.34	21	ND	U	0.33	20	ND	U	0.37	23	ND	U	0.34	21
Benzo(g,h,i)perylene	ND	ND	x	ND	U	0.48	20	ND	U	0.50	21	ND	U	0.47	20	ND	U	0.48	21	ND	U	0.48	20	ND	U	0.53	23	ND	U	0.48	21
Benzo(k)fluoranthene	ND	ND	x	ND	U	0.29	20	ND	U	0.30	21	ND	U	0.29	20	ND	U	0.29	21	ND	U	0.29	20	ND	U	0.32	23	ND	U	0.29	21
Chrysene[HMW]	0.44	ND	x	ND	U	0.28	20	ND	U	0.29	21	0.44	J	0.28	20	ND	U	0.28	21	ND	U	0.28	20	ND	U	0.31	23	ND	U	0.28	21
Dibenzo(a,h)anthracene[HMW]	ND	ND	x	ND	U	0.43	20	ND	U	0.45	21	ND	U	0.43	20	ND	U	0.44	21	ND	U	0.43	20	ND	U	0.48	23	ND	U	0.44	21
Fluoranthene[HMW]	0.42	ND	x	ND	U	0.25	20	ND	U	0.26	21	0.42	J	0.25	20	ND	U	0.25	21	ND	U	0.25	20	ND	U	0.28	23	ND	U	0.25	21
Fluorene[LMW]	ND	ND	x	ND	U	0.26	20	ND	U	0.27	21	ND	U	0.26	20	ND	U	0.27	21	ND	U	0.26	20	ND	U	0.29	23	ND	U	0.27	21
Indeno(1,2,3-cd)pyrene	ND	ND	x	ND	U	0.48	20	ND	U	0.50	21	ND	U	0.48	20	ND	U	0.49	21	ND	U	0.48	20	ND	U	0.54	23	ND	U	0.49	21
Naphthalene[LMW]	0.95	ND	x	ND	U	0.75	20	0.95	J	0.78	21	0.76	J	0.75	20	ND	U	0.76	21	ND	U	0.75	20	ND	U	0.84	23	ND	U	0.76	21
Phenanthrene[LMW]	0.41	0.45	x	ND	U	0.33	20	0.36	J	0.35	21	0.41	J	0.33	20	ND	U	0.34	21	0.42	J	0.33	20	0.45	J	0.37	23	0.42	J	0.34	21
Pyrene[HMW]	0.32	ND	x	0.29	J	0.25	20	ND	U	0.26	21	0.32	J	0.25	20	ND	U	0.26	21	ND	U	0.25	20	ND	U	0.28	23	ND	U	0.26	21
Total LMW PAHs[3]	3.24	3.36	x	2.92	–	–	–	3.24	–	–	–	3.01	–	–	–	2.98	–	–	–	3.01	–	–	–	3.36	–	–	–	3.06	–	–	–
TOTAL HMW PAHs[3]	2.44	1.98	x	1.81	–	–	–	1.84	–	–	–	2.44	–	–	–	1.80	–	–	–	1.77	–	–	–	1.98	–	–	–	1.80	–	–	–
Total PAHs[3]	7.49	7.36	x	6.54	–	–	–	6.97	–	–	–	7.49	–	–	–	6.62	–	–	–	6.59	–	–	–	7.36	–	–	–	6.70	–	–	–

[1] FDA = U.S. Food and Drug Administration levels for crustacea (from Appendix H of the SERIM).

[2] MRL = method reporting limit is defined as the lowest instrument calibration standard.

[3] U-qualified data calculated as the method detection limit (MDL).

[LMW] Low molecular weight PAHs (NOAA 1989).

[HMW] High molecular weight PAHs (NOAA 1989).

– = no qualifier needed or no analysis performed for that analyte.

J = the result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

ND = not detected at or above the MDL.

U = the compound was analyzed for but not detected at or above the MDL.

x = no FDA level published for parameter.

Source: Columbia Analytical Services, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

TABLE 34
Results of Wet Weight Bioaccumulated PCB Analyses of Tissue Collected during the May 2011 Port Everglades Survey

					Species Sampled:	Spotted Hake														Jonah Crab									
	Max. Detected Concentrations				Sample ID:	5-10-COMP-A				6-7-COMP-A				9-TIS-A				9-TIS-A (Field Split)				5-10-COMP-B				9-TIS-B				14-TIS-A			
					Site Number:	Outside Expansion Areas				Inside Expansion Areas				Outside Expansion Areas				Outside Expansion Areas				Outside Expansion Areas				Outside Expansion Areas				Inside Expansion Areas			
Analyte	Spotted Hake µg/kg	Jonah Crab µg/kg	FDA Level[1]: Crustacea µg/kg	FDA Tolerance Level[2]: Edible Fish Tissue µg/kg		Result µg/kg	Qualifier	MDL	MRL[3]	Result µg/kg	Qualifier	MDL	MRL[3]	Result µg/kg	Qualifier	MDL	MRL[3]	Result µg/kg	Qualifier	MDL	MRL[3]	Result µg/kg	Qualifier	MDL	MRL[3]	Result µg/kg	Qualifier	MDL	MRL[3]	Result µg/kg	Qualifier	MDL	MRL[3]
PCB 8[NOAA]	ND	ND	x	x		ND	U	0.10	0.45	ND	U	0.10	0.43	ND	U	0.10	0.45	ND	U	0.10	0.45	ND	U	0.10	0.43	ND	U	0.10	0.44	ND	U	0.10	0.45
PCB 18[NOAA]	ND	ND	x	x		ND	U	0.098	0.45	ND	U	0.098	0.43	ND	U	0.098	0.45	ND	U	0.098	0.45	ND	U	0.098	0.43	ND	U	0.098	0.44	ND	U	0.098	0.45
PCB 28[NOAA]	ND	ND	x	x		ND	U	0.13	0.45	ND	U	0.13	0.43	ND	U	0.13	0.45	ND	U	0.13	0.45	ND	U	0.13	0.43	ND	U	0.13	0.44	ND	U	0.13	0.45
PCB 44[NOAA]	ND	ND	x	x		ND	U	0.35	0.45	ND	U	0.35	0.43	ND	U	0.35	0.45	ND	U	0.35	0.45	ND	U	0.35	0.43	ND	U	0.35	0.44	ND	U	0.35	0.45
PCB 49	ND	ND	x	x		ND	U	0.11	0.45	ND	U	0.11	0.43	ND	U	0.11	0.45	ND	U	0.11	0.45	ND	U	0.11	0.43	ND	U	0.11	0.44	ND	U	0.11	0.45
PCB 52[NOAA]	ND	ND	x	x		ND	U	0.39	0.45	ND	U	0.39	0.43	ND	U	0.39	0.45	ND	U	0.39	0.45	ND	U	0.39	0.43	ND	U	0.39	0.44	ND	U	0.39	0.45
PCB 66[NOAA]	ND	ND	x	x		ND	U	0.59	0.89	ND	U	0.59	0.86	ND	U	0.59	0.90	ND	U	0.59	0.89	ND	U	0.59	0.85	ND	U	0.59	0.88	ND	U	0.59	0.89
PCB 77	ND	ND	x	x		ND	U	0.12	0.45	ND	U	0.12	0.43	ND	U	0.12	0.45	ND	U	0.12	0.45	ND	U	0.12	0.43	ND	U	0.12	0.44	ND	U	0.12	0.45
PCB 87	ND	ND	x	x		ND	U,i	0.48	0.48	ND	U	0.16	0.43	ND	U,i	0.19	0.45	ND	U,i	0.50	0.50	ND	U,i	0.69	0.69	ND	U,i	1.1	1.1	ND	U,i	0.78	0.78
PCB 101[NOAA]	ND	ND	x	x		ND	U	0.39	0.45	ND	U	0.39	0.43	ND	U	0.39	0.45	ND	U	0.39	0.45	ND	U	0.39	0.43	ND	U	0.39	0.44	ND	U	0.39	0.45
PCB 105[NOAA]	ND	ND	x	x		ND	U	0.10	0.45	ND	U	0.10	0.43	ND	U	0.10	0.45	ND	U	0.10	0.45	ND	U	0.10	0.43	ND	U	0.10	0.44	ND	U	0.10	0.45
PCB 118[NOAA]	0.11	0.11	x	x		0.11	J	0.11	0.45	ND	U	0.11	0.43	ND	U	0.11	0.45	ND	U	0.11	0.45	ND	U	0.11	0.43	0.11	J	0.11	0.44	ND	U	0.11	0.45
PCB 126	ND	ND	x	x		ND	U	0.14	0.45	ND	U	0.14	0.43	ND	U	0.14	0.45	ND	U	0.14	0.45	ND	U	0.14	0.43	ND	U	0.14	0.44	ND	U	0.14	0.45
PCB 128[NOAA]	ND	ND	x	x		ND	U	0.16	0.45	ND	U	0.16	0.43	ND	U	0.16	0.45	ND	U	0.16	0.45	ND	U	0.16	0.43	ND	U	0.16	0.44	ND	U	0.16	0.45
PCB 138[NOAA]	0.23	0.25	x	x		0.23	J	0.091	0.45	ND	U	0.091	0.43	0.10	J	0.091	0.45	0.21	J	0.091	0.45	0.16	J	0.091	0.43	0.25	J	0.091	0.44	0.21	J	0.091	0.45
PCB 153[NOAA]	0.14	0.17	x	x		0.14	J,P	0.13	0.45	ND	U	0.13	0.43	ND	U	0.13	0.45	ND	U	0.13	0.45	ND	U	0.13	0.43	0.17	J,P	0.13	0.44	0.17	J,P	0.13	0.45
PCB 156	ND	ND	x	x		ND	U	0.56	0.89	ND	U	0.56	0.86	ND	U	0.56	0.90	ND	U	0.56	0.89	ND	U	0.56	0.85	ND	U	0.56	0.88	ND	U	0.56	0.89
PCB 169	ND	ND	x	x		ND	U	0.089	0.45	ND	U	0.089	0.43	ND	U	0.089	0.45	ND	U	0.089	0.45	ND	U	0.089	0.43	ND	U	0.089	0.44	ND	U	0.089	0.45
PCB 170[NOAA]	ND	ND	x	x		ND	U	0.38	0.45	ND	U	0.38	0.43	ND	U	0.38	0.45	ND	U	0.38	0.45	ND	U	0.38	0.43	ND	U	0.38	0.44	ND	U	0.38	0.45
PCB 180[NOAA]	ND	ND	x	x		ND	U	0.34	0.45	ND	U	0.34	0.43	ND	U	0.34	0.45	ND	U	0.34	0.45	ND	U	0.34	0.43	ND	U	0.34	0.44	ND	U	0.34	0.45
PCB 183	ND	ND	x	x		ND	U	0.15	0.45	ND	U	0.15	0.43	ND	U	0.15	0.45	ND	U	0.15	0.45	ND	U	0.15	0.43	ND	U	0.15	0.44	ND	U	0.15	0.45
PCB 184	ND	ND	x	x		ND	U	0.13	0.45	ND	U	0.13	0.43	ND	U	0.13	0.45	ND	U	0.13	0.45	ND	U	0.13	0.43	ND	U	0.13	0.44	ND	U,i	0.14	0.45
PCB 187[NOAA]	0.17	0.17	x	x		0.17	J	0.083	0.45	ND	U	0.083	0.43	ND	U	0.083	0.45	0.14	J	0.083	0.45	0.091	J,P	0.083	0.43	0.17	J	0.083	0.44	0.14	J	0.083	0.45
PCB 195[NOAA]	ND	ND	x	x		ND	U	0.33	0.45	ND	U	0.33	0.43	ND	U	0.33	0.45	ND	U	0.33	0.45	ND	U	0.33	0.43	ND	U	0.33	0.44	ND	U	0.33	0.45
PCB 206[NOAA]	ND	ND	x	x		ND	U	0.20	0.45	ND	U	0.20	0.43	ND	U	0.20	0.45	ND	U	0.20	0.45	ND	U	0.20	0.43	ND	U	0.20	0.44	ND	U	0.20	0.45
PCB 209[NOAA]	ND	ND	x	x		ND	U	0.15	0.45	ND	U	0.15	0.43	ND	U	0.15	0.45	ND	U	0.15	0.45	ND	U	0.15	0.43	ND	U	0.15	0.44	ND	U	0.15	0.45
Total EPA Region 4 PCBs[4]	6.14	6.81	2000	2000		6.14	–	–	–	5.58	–	–	–	5.62	–	–	–	6.10	–	–	–	6.19	–	–	–	6.81	–	–	–	6.43	–	–	–
Total NOAA PCBs[5]	8.72	8.82	x	x		8.72	–	–	–	8.24	–	–	–	8.26	–	–	–	8.60	–	–	–	8.40	–	–	–	8.82	–	–	–	8.68	–	–	–

[1] FDA = U.S. Food and Drug Administration levels for crustacea from Appendix H of the SERIM with decimal places preserved from the source document (FDA 2001).

[2] FDA tolerance level is taken from 21 CFR 109.30 and converted from 2 ppm. Edible tissue includes muscle and does not explicidly exclude skin.

[3] MRL = method reporting limit, assigned by Columbia Analytical Services to a fixed factor above the method detection limit (MDL) depending on the analyte, unless otherwise specified.

[4] Total EPA Region 4 PCBs, see SERIM Section 7.3. U-qualified data calculated as the MDL.

[5] Total NOAA PCBs, see SERIM Section 7.3 for details. U-qualified data calculated as the MDL.

P = the GC or HPLC confirmaton criteria was exceeded. The relative percent difference is greater than 40% between the two analytical results (25% for CLP Pesticides).

[NOAA] National Oceanic and Atmospheric Administration PCB congeners.

i = the MDL has been elevated due to chromatographic interference.

J = the result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

U = the compound was analyzed for but not detected at or above the MDL.

– = no qualifier needed.

ND = not detected at or above the MDL.

x = no FDA level published for parameter.

Source: Columbia Analytical Services, Inc. Compiled by: ANAMAR Environmental Consulting, Inc.

APPENDICES
are included only
on the enclosed CD.

APPENDICES

To conserve space, all appendices are located on the attached CD only.

APPENDIX A Sampling and Analysis Plan/Quality Assurance Project Plan
APPENDIX B Field Data Sheets and Field Photographs
APPENDIX C Letter of Acknowledgement from National Marine Fisheries Service
APPENDIX D Benthic Infaunal Report by Barry A. Vittor & Associates, Inc.
APPENDIX E USEPA Port Everglades Harbor ODMDS Expansion Designation Survey Report
APPENDIX F Sediment and Water Physical Lab Data
APPENDIX G Sediment and Tissue Chemical Lab Data
APPENDIX H Notes on Fish Dissections
APPENDIX I Chemical Quality Assurance Report